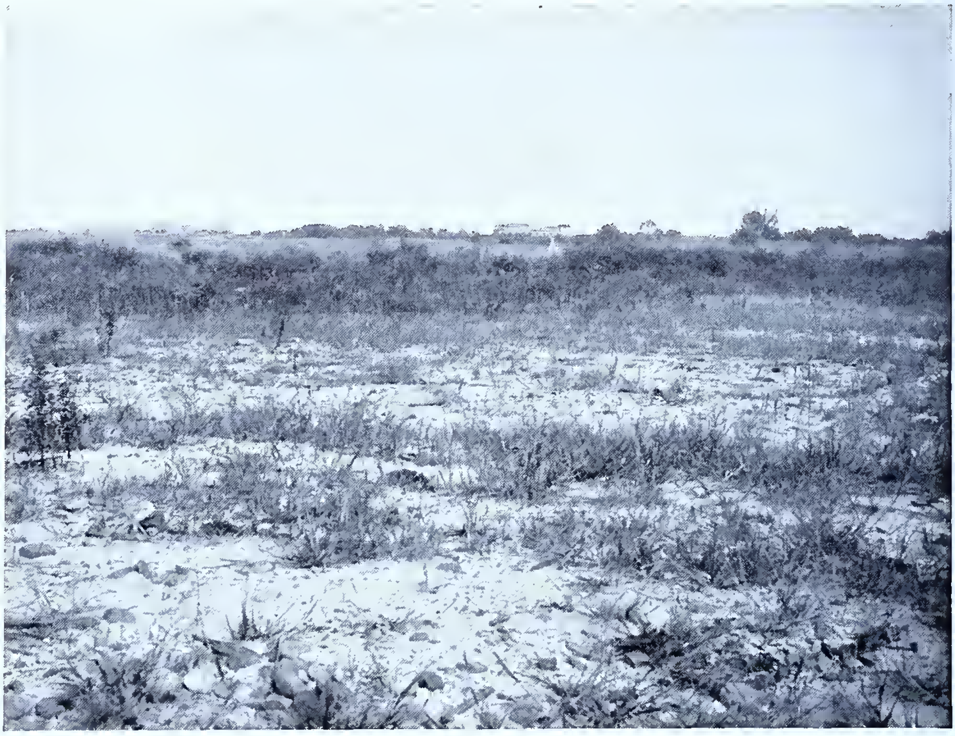
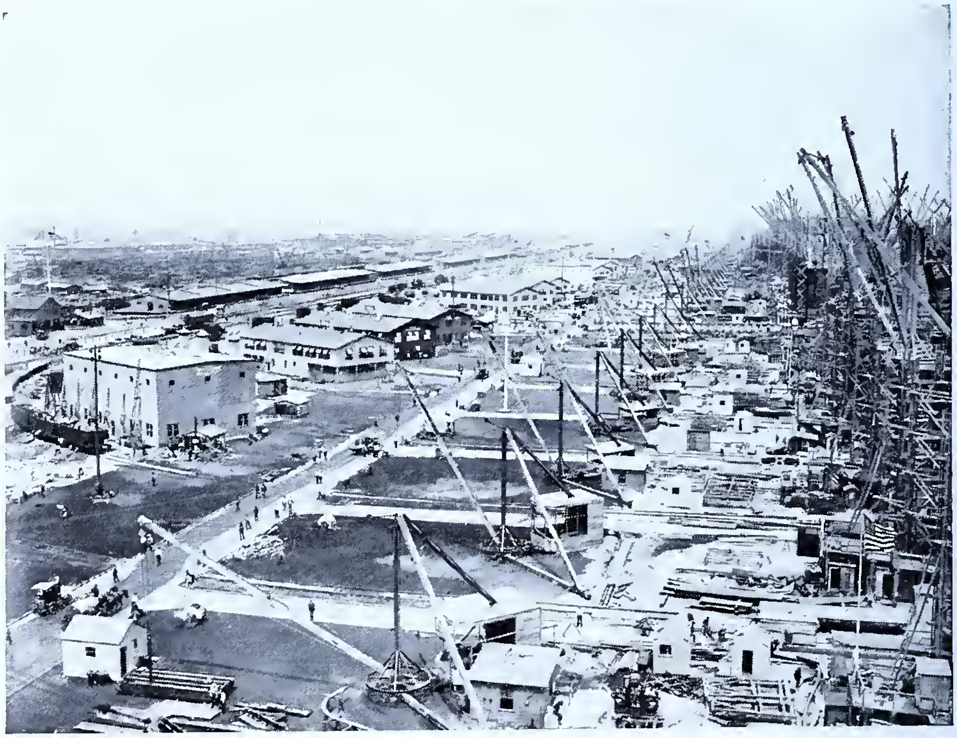


SEPTEMBER 20, 1917

HOG ISLAND



JULY 9, 1918

9

THE BRIDGE OF SHIPS

By

ALEXANDER H. BEARD

AMERICAN INTERNATIONAL CORPORATION
120 BROADWAY · NEW YORK

THE American International Corporation, organized by bankers, business men and engineers of the United States, aims

First—To establish friendly commercial relations with all countries of the world;

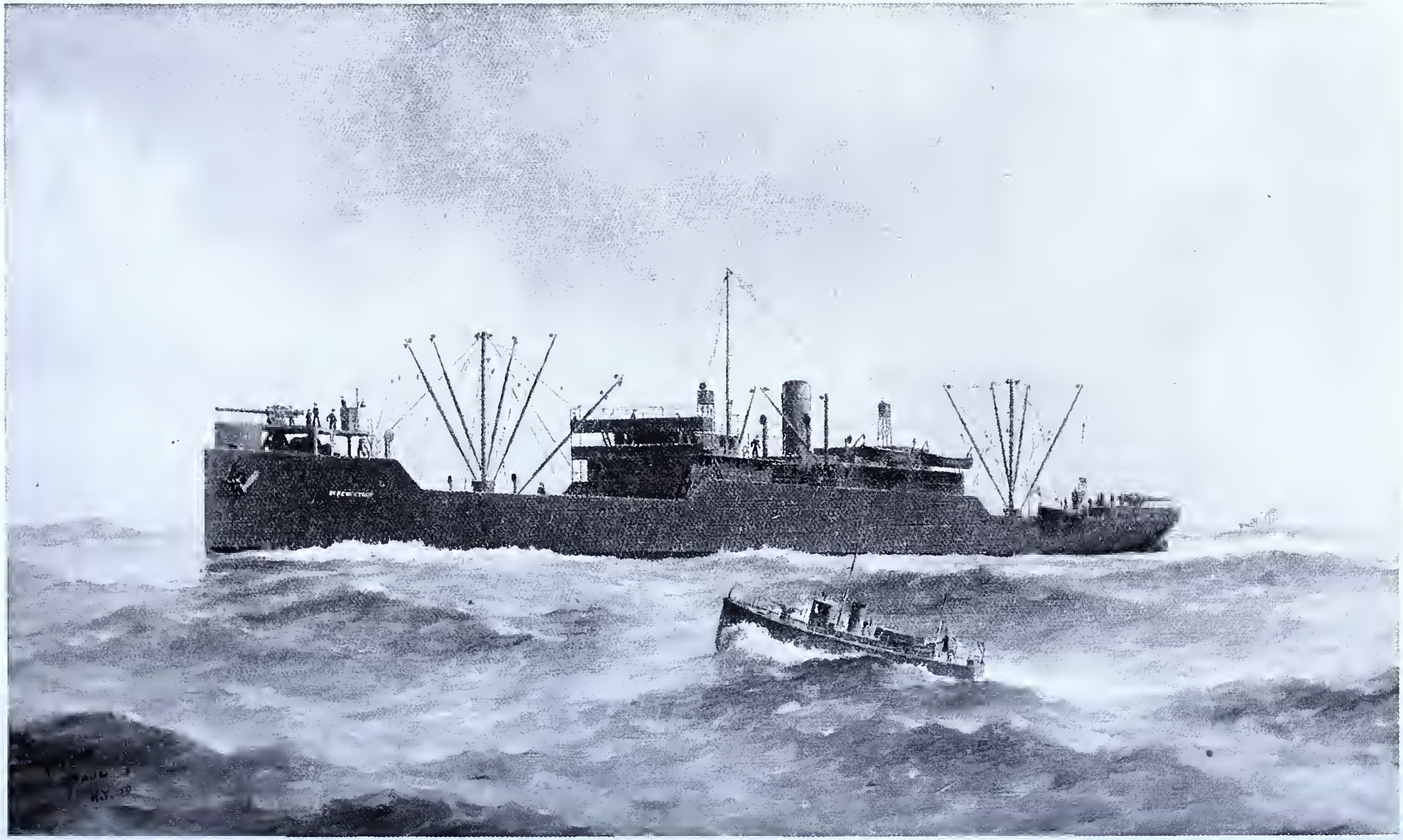
Second—To participate in the development of such enterprises—domestic or foreign—as will broaden the scope of American activities and lead to a better understanding of international relations;

Third—To promote the organization of corporations or associations to bring together foreign and American bankers, business men and engineers, for the transaction of business and the development of undertakings which will be mutually advantageous.

HOG ISLAND is a peculiarly American achievement, born of a great necessity. It is American in its colossal size and in the combined simplicity and boldness of its design; American too in the thoroughness and speed of its realization. It stands to-day by far the greatest shipyard in the world. Alone it can launch each year a tonnage three times as great as that which America produced annually before 1914. The nation, therefore, may surely permit itself a moment of just pride in the work of its Government as it sees the first of Hog Island's ships afloat. In this pride we all have our share as Americans, but the largest share is that of the men who labored to transform a marshy waste into this great city of ships. The Emergency Fleet Corporation of the United States Shipping Board too may well pause a moment to say that its work is well done. In days to come, when there is time to take stock of these things, it will be written that this arm of the Government indeed deserved well of its country in the great war.

For the American International Corporation and its associates it is enough to say that they have had a part in an enterprise which will forever be remembered as one the great achievements of a great epoch.

Charles Augustus Stone.



THE TYPE "A" SHIP

THE BRIDGE OF SHIPS

(Reprinted by permission from
"The Outlook" of August 7, 1918)

SEA-POWER—AND A CHALLENGE

> NOTICE
>
> Travelers intending to embark on the Atlantic voyage are reminded that a state of war exists between Germany and her Allies and Great Britain and her Allies; that the zone of war includes the waters adjacent to the British Isles; that, in accordance with formal notice given by the Imperial German Government, vessels flying the flag of Great Britain, or of any of her Allies, are liable to destruction in those waters and that travelers sailing in the war zone on ships of Great Britain or her Allies do so at their own risk.
>
> IMPERIAL GERMAN EMBASSY.
>
> *Washington, D. C., April 22, 1915.*

THE above, inserted among the shipping advertisements in the New York *Times* on the morning of May 1, 1915, attracted the notice only of the curious. It was the day the *Lusitania* was to leave New York, with a crowded passenger list. There was a little speculation; in a vague, indefinable way that notice was connected with that departure; but few passages were canceled, and, where any comment was made, men said that "they would not dare sink the *Lusitania*." Then came that hideous day, May 7, 1915, and that mighty British steamer went down "in twenty minutes," followed by the ghastly exultation of a nation galvanized into murder-efficiency. But there seemed to be a further explanation of such evil rejoicing. The *Lusitania* stood for Britain's supremacy of the sea; more than that, it stood for all sea-power (of which Britain was the guardian), which in all modern history has held in check the encroachment of land-power, and was now alone thwarting Germany's plans. The world was stunned by the mere horror of what had been done; the watchers that realized, by the challenge.

SEWERAGE AND WATER-PIPE TRENCHING, OCTOBER 22, 1917

VIEW N. E. FROM WAY GROUP NO. 2, NOVEMBER 23, 1917

Those that understood knew that the word had gone forth "no quarter" on the sea, as it had already gone forth from the same voice on land. The submarine had been assigned a new and monstrous mission, and the bid for world-power on land, conceived in darkness, was henceforth to urge its claims from underneath the sea.

That day was the beginning. The *Arabic*, the *Ancona*, the *Persia*, followed in quick succession during the balance of the year 1915, to mention only those that were outstanding international incidents. There was besides the growing number of smaller vessels that were being sent to the bottom. Attention was centered on America's diplomatic negotiations. The argument was raised that these vessels carried war cargoes. But something else was observable. *Neutral steamers—Norwegian, Danish, Dutch, American—were being sunk, west-bound, in ballast!* The flag or cargo or destination did not seem to matter. As a certain observer commented on this: "The magnitude of the injustice paralyses the judgment." Men began conjecturing darkly what this might mean. A few realized. The world's whole supply of ships was being whittled down! It was simply a matter of pencil and paper and a book of reference—*Lloyd's Register of Shipping.*

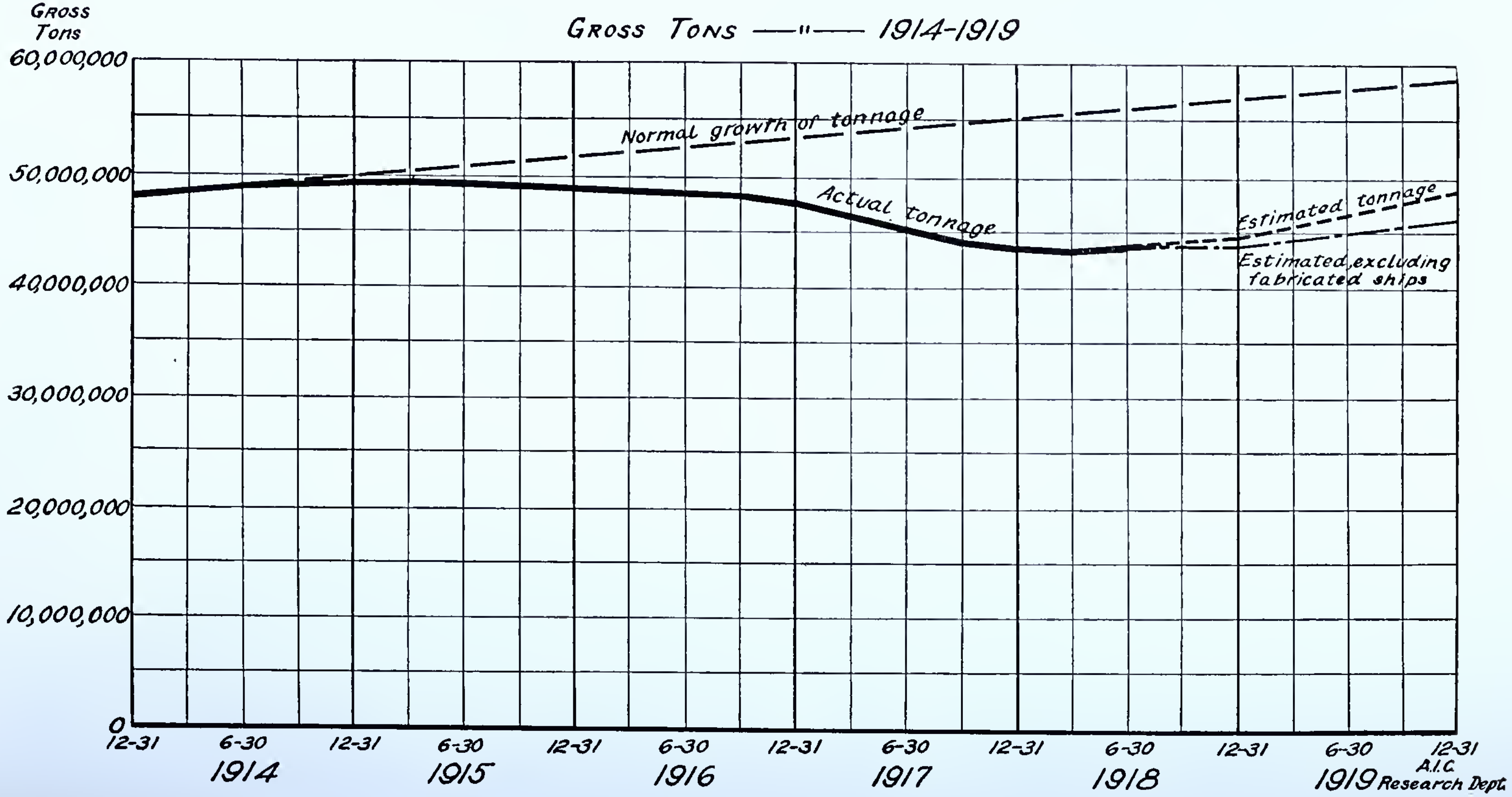
Nineteen hundred and sixteen was a dark year, full of vague surmise and uneasy reckonings. The toll of disaster at sea was not only mounting continuously, but ever faster. The submarines had sunk 1,700,000 tons (gross) of ships in 1915 alone, and now they were sending them down at a rate which would account for not only as many more in 1916, but a million tons besides! If Germany meant to go on with wholesale destruction of merchant ships—and who really doubted it?—the feeling began to grow in America that we must take some thought of building them. "Give us an American merchant marine," which had been for years only a voice crying in the wilderness, became now an ever more imperative demand. Some answer at last seemed to be forthcoming. In September, 1916, the President signed the Shipping Bill. This called for a United States Shipping Board, whose duty was to be, among other things, to create "a naval auxiliary . . . and a merchant marine to meet the requirements of the United States."

In the meantime, the American shipyards, that for years had languished, suddenly found themselves pressed with orders for ships, and many began to expand their capacities. To the extent that shipbuilding was then conceived of, we were taking thought of building! Mr. Stevenson Taylor, President of the Society of Naval Architects and Marine Engineers, addressing them at their

MERCHANT SHIP TONNAGE OF THE WORLD

Showing variation from what would have been the
normal growth of tonnage had there been no war

GROSS TONS —"— 1914-1919



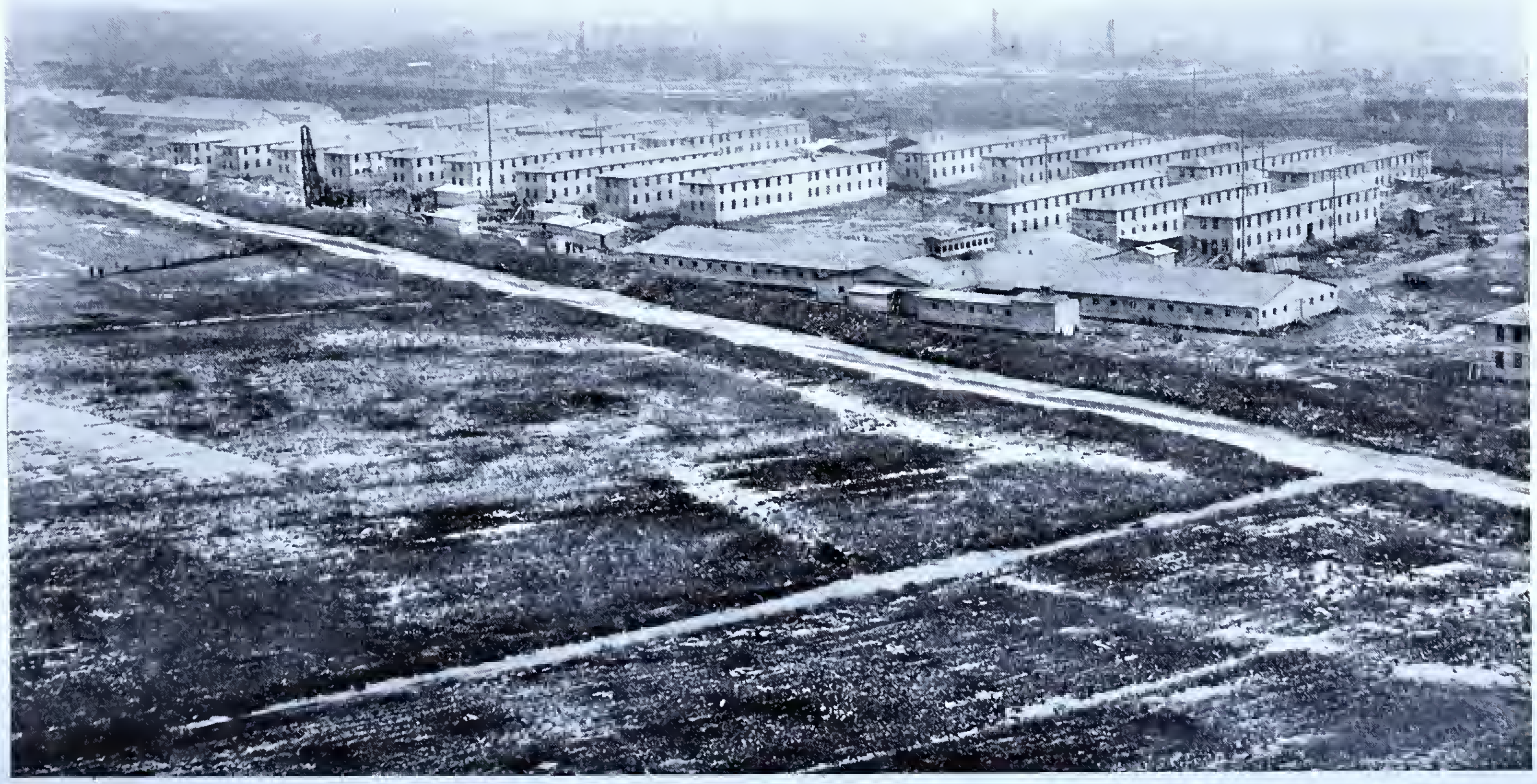
A.I.C. Research Dept.

annual meeting in November, 1916, reported that "at present the shipyards of the United States are building nearly 1,500,000 tons (gross) of steel and over 50,000 tons of wood vessels to be finished during the next two years." But he also reported that 5,000,000 tons of merchant vessels had been destroyed since the beginning of the war. With a normal world tonnage of about 50,000,000, 5,000,000 had been sunk, and another 5,000,000 were interned by the war, a total of about one-fifth no longer available for any service, war or peace. It was evident that ship shortage would be a serious problem for some time to come.

During this increasingly critical period, the American International Corporation, which was created to promote American interests in foreign fields, had not been inactive. Mr. George J. Baldwin, in charge of this field of the Corporation's work, realized early in 1916 that shipbuilding and the creation of a merchant marine was not only necessary for the development of America's foreign trade, but for the establishment of America's responsible position among the nations. Very well. The American International Corporation would become a builder of ships. The best engineers and naval architects available were commissioned to examine and report upon all the important shipyards along the Atlantic coast. They reported that of all these yards the New York Shipbuilding Company's, at Camden, New Jersey, on the Delaware, seemed to be the best organized and most efficient. Its reputation as a builder of many of our finest battleships and of such American merchant steamers as the *Mongolia* and *Manchuria*, recently of the Pacific Mail, was one of sterling quality. It was decided to purchase; the deal was consummated; in November, 1916, the company was reorganized as the New York Shipbuilding Corporation, and two million dollars was immediately allocated for an important expansion in building capacity.

WHERE ARE THE SHIPS?

In 1917 events come crowding. On January 31st, the fall of the sword of Damocles—unrestricted submarine warfare. On April 6th our inevitable entry into the war. Staggering figures for sinkings of merchant ships, reaching for the month of April over 800,000 tons gross register, or, in terms of cargo-carrying capacity, 1,300,000 tons. British shipbuilding, usually about 60% of the world's, had fallen to about one-third its normal output. Shipbuilding for neutrals and all the Allies, including the new Ally, the United States, was thus hardly more than one-fifth of this April rate of destruction.

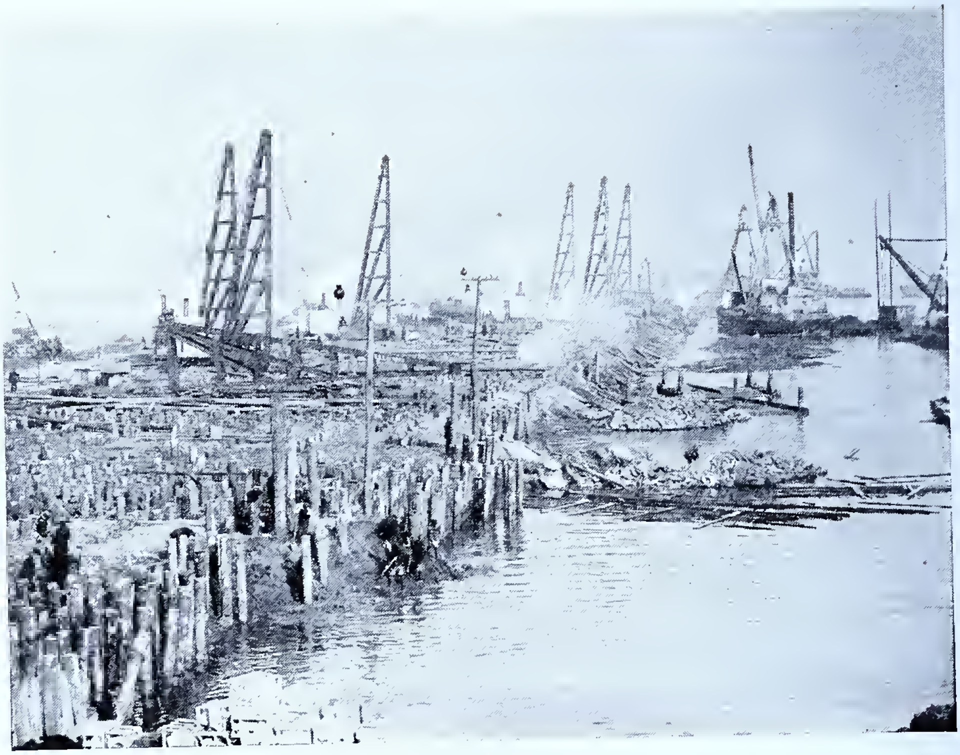


WORKMEN'S BARRACKS LOOKING EAST, DECEMBER 20, 1917

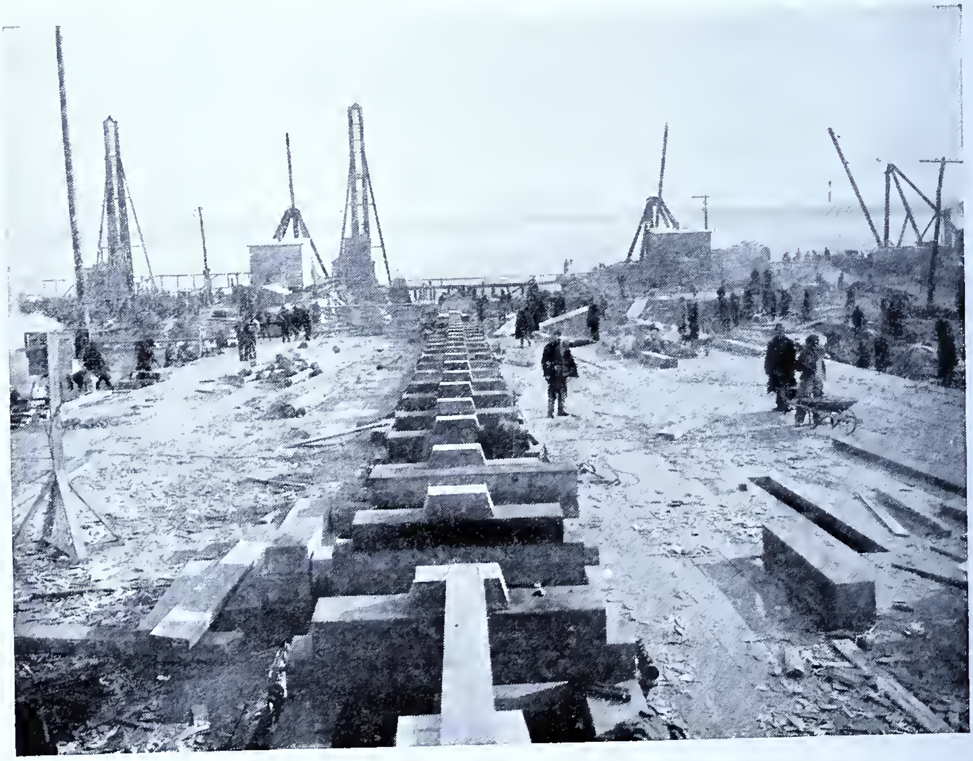
The writing was on the wall, unless this proportion could be somehow reversed. Our Allies' position was precarious for supplies. People were saying that Britain could not hold out, she would starve; that in any event we could not send troops to France—there simply were not enough ships. Then came the realization that Britain would hold out; further, that we had to send troops; therefore we must build ships. We must build them because our Allies needed them badly; also because to us they were the *sine qua non* of participation in a war in which we had announced our intention to join to the uttermost.

"To create a merchant marine to meet the requirements of the United States." That was the duty of the Shipping Board. How oddly such a phrase sounded in the face of such a crisis, and how little had they foreseen the ultimate interpretation of it! Here was a task to put a whole nation at work, and to call for the resources of the nation's treasury. To organize, direct and apportion that task they formed a great Government corporation and gave it the name that was in everyone's mind—the United States Shipping Board Emergency Fleet Corporation. For the understanding of that emergency seemed to sweep like a wave over the country. The cry went forth from England: "Give us ships!" The American newspapers, then the American people, took up the cry until "Ships, Ships and then more Ships!" became a mighty chorus from Maine to California. Some said, "Give us steel ships"; others, "Give us wooden ships"; while a few, thinking of the immediate need for any ships that would float, said, "Give us steel ships, wooden ships, composite ships, and if there is anything else out of which you can make ships, give us that kind, too." Through it all ran the feeling that something extraordinary and unheard of would have to be found to produce the ships in sufficient numbers. Suddenly to convert our immense forests into a mighty fleet of wooden ships that should confound the submarines by their very numbers appealed to the imagination. The wooden ships did fill a great need, but they could not ultimately solve our problem. In an age of steel it was in steel shipbuilding that the hope of the future lay.

During these anxious days the Emergency Fleet Corporation were doing what they could. There were about 2,800,000 tons carrying capacity (dead-weight) in steel ships already under way in the going yards when war was declared, and which the President could commandeer. By the middle of 1917 they had been able to place new contracts for about 1,800,000 tons more, of which one-third was for steel and two-thirds for wooden ships. They



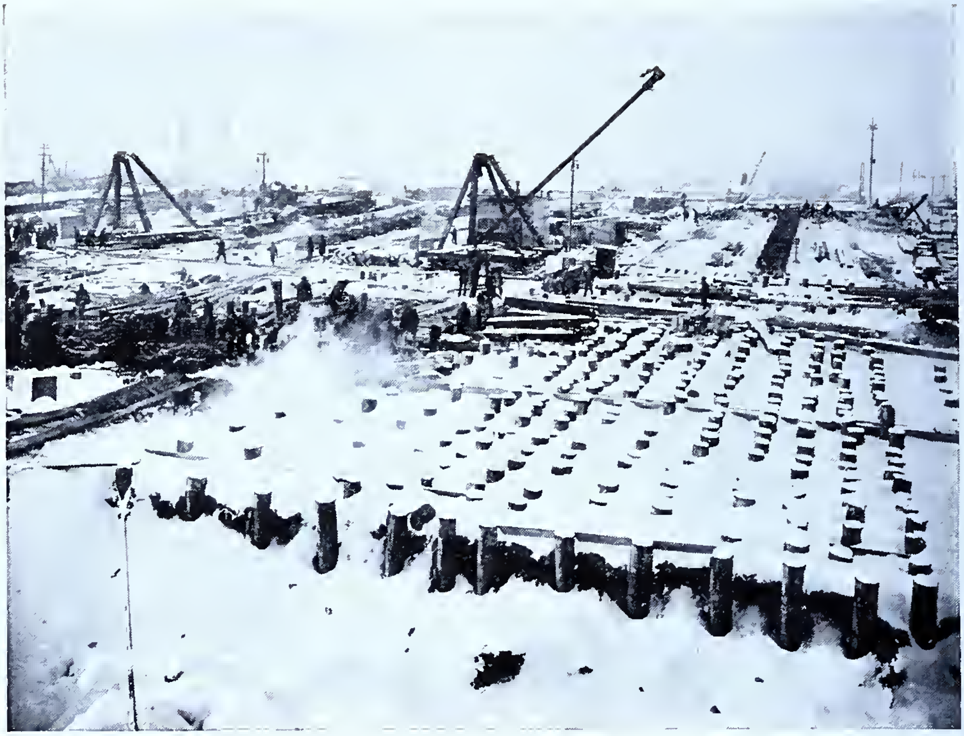
WAY GROUP NO. 1 EAST FROM MAIN WHARF, DECEMBER 2, 1917



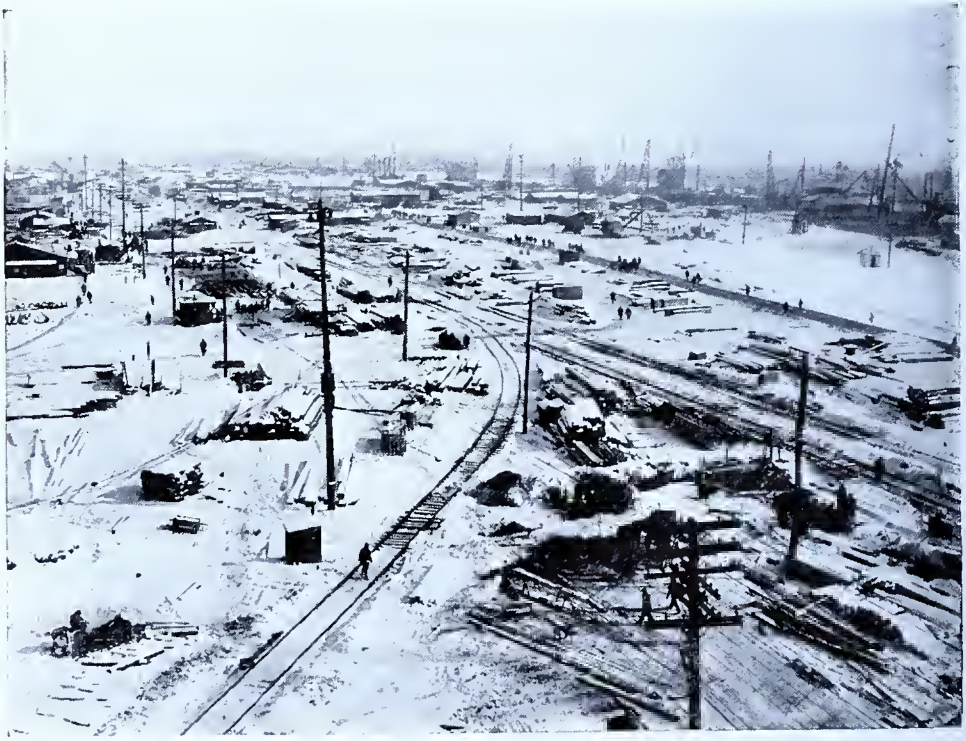
LOOKING DOWN THE KEEL BLOCKS OF SHIPWAY NO. 1, JANUARY 18, 1918 had done this by distributing orders to the already hard-pressed shipyards, which were building new shops and ways as fast as they could, and by encouraging the building of new yards. Of these latter an extraordinary number had been started for both steel and wooden ships. With all this tonnage, building or ordered, it seemed possible to complete about 3,000,000 tons in the next eighteen months. Compared to our total shipbuilding for 1916—800,000 tons dead-weight—it was a worthy showing. It seemed to be America's utmost.

But how inadequate compared to the needs of our Allies and ourselves! There was already at the end of 1916, as we have seen, a world shortage of ship tonnage of about one-fifth, or twenty per cent. At this height of submarine warfare this shortage was increasing (destruction against construction) at the rate of over one per cent. of the normal world tonnage per month, and it was not then known that the rate of destruction could be curtailed. In addition to that we were preparing to send an army to Europe, which had not only to be put overseas as speedily as possible, but maintained there under arms. Leaving out of count the ships for transporting these troops, it was calculated that five tons of shipping space per annum would be needed per man for maintaining them. This would mean 5,000,000 tons of ships for this use alone for every million men, and we were to send several million men.

The gist of all calculations was that we needed at least 6,000,000 tons of ships just as soon as we could get them. But in spite of all calculations, what more could be done? The shipyards, old and new, were taxed to capacity; they were speeding up all they could, and, what was most serious of all, they had begun to bid against each other for skilled shipbuilders. The supply of wooden-ship workers had quickly been exhausted, and now even the steel shipyards were finding it difficult to man their shops and ways. The industry seemed to have reached the limit of expansion. But right at this point, in July, 1917, the Fleet Corporation announced their intention of asking Congress for money to double their estimated 3,000,000-ton output by building simultaneously another 3,000,000 tons! What did they have in mind? What idea was behind them to prompt that action? Evidently some conception of shipbuilding altogether new, brushing aside time-honored limitations, revolutionary!



GROUP NO. 1, SHIPWAYS NOS. 1, 2, 3, AND 4, JANUARY 22, 1918



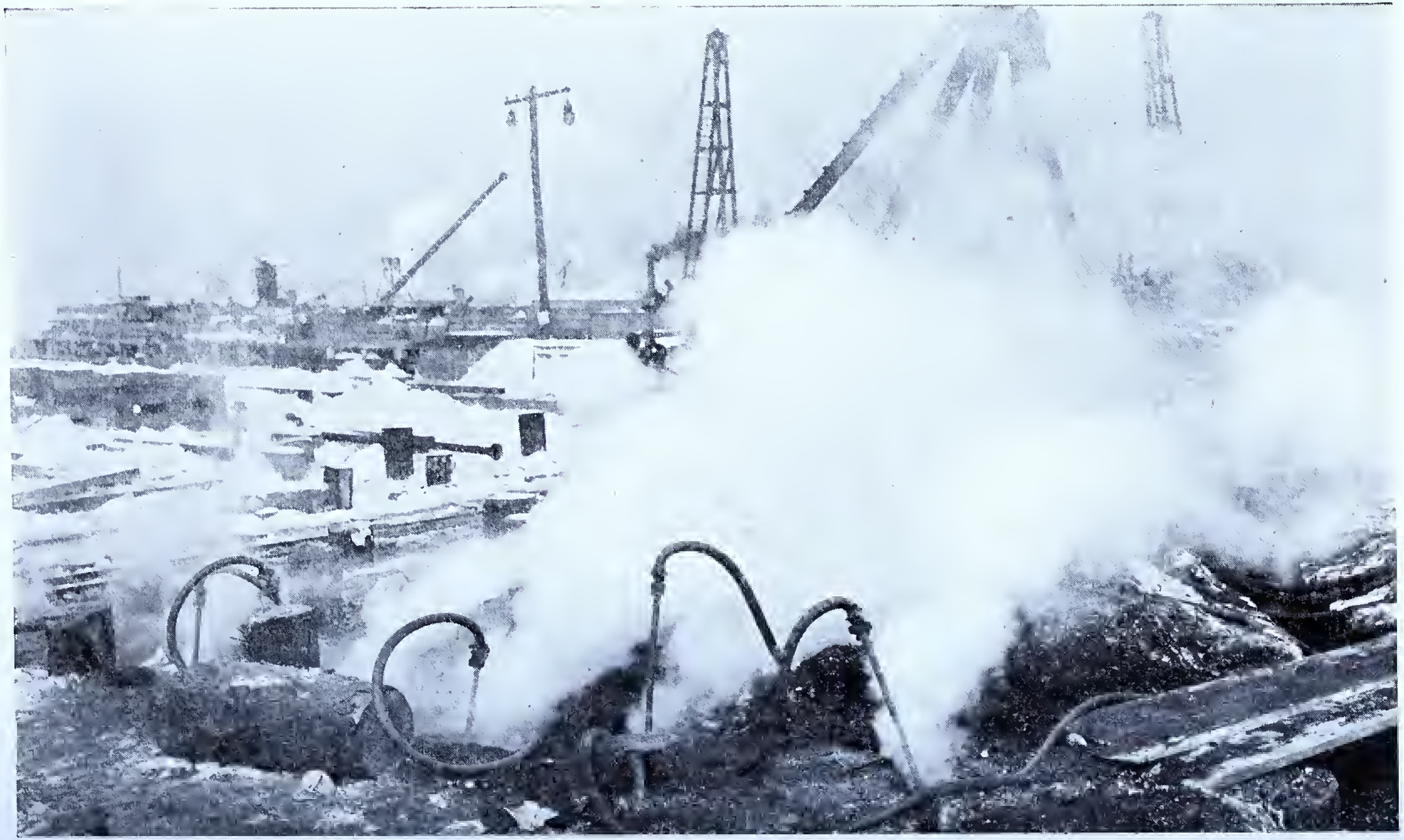
LOOKING EAST FROM CENTRAL FIRE STATION, JANUARY 23, 1918

THE NEW IDEA

There did not seem to be anything out of which to produce this 3,000,000 tons additional, unless it were some new idea. That idea was at hand. We are fighting this war with new ideas, anyway, and in the vision of a group of big men of big organizations a revolution in steel shipbuilding had been carried out.

Steel shipbuilding, like all shipbuilding, was an art of tradition. A new method was the only solution. In the then established yards, old and new, ships were built as it were in hand-wrought, made-to-order fashion, the way they had always been built (except that steel had supplanted wood) ever since the venturesome spirit of man, *illi robur et aes triplex,* had first trusted his treasure and his hope to the seas. Every vital part of the ship, shell, frame, motive power, rigging, was wrought in special shops adjacent to the shipbuilding ways. Only the minor auxiliary equipment, such as steering engines, windlasses, capstans, pumps, was ordered from outside manufacturers. In the first place, every order for a ship was apt to be for a different type, with special features demanded in the design. Duplicates of previously built types could be ordered, but, except that the drawings would be already made, execution would be the same as for a newly designed ship.

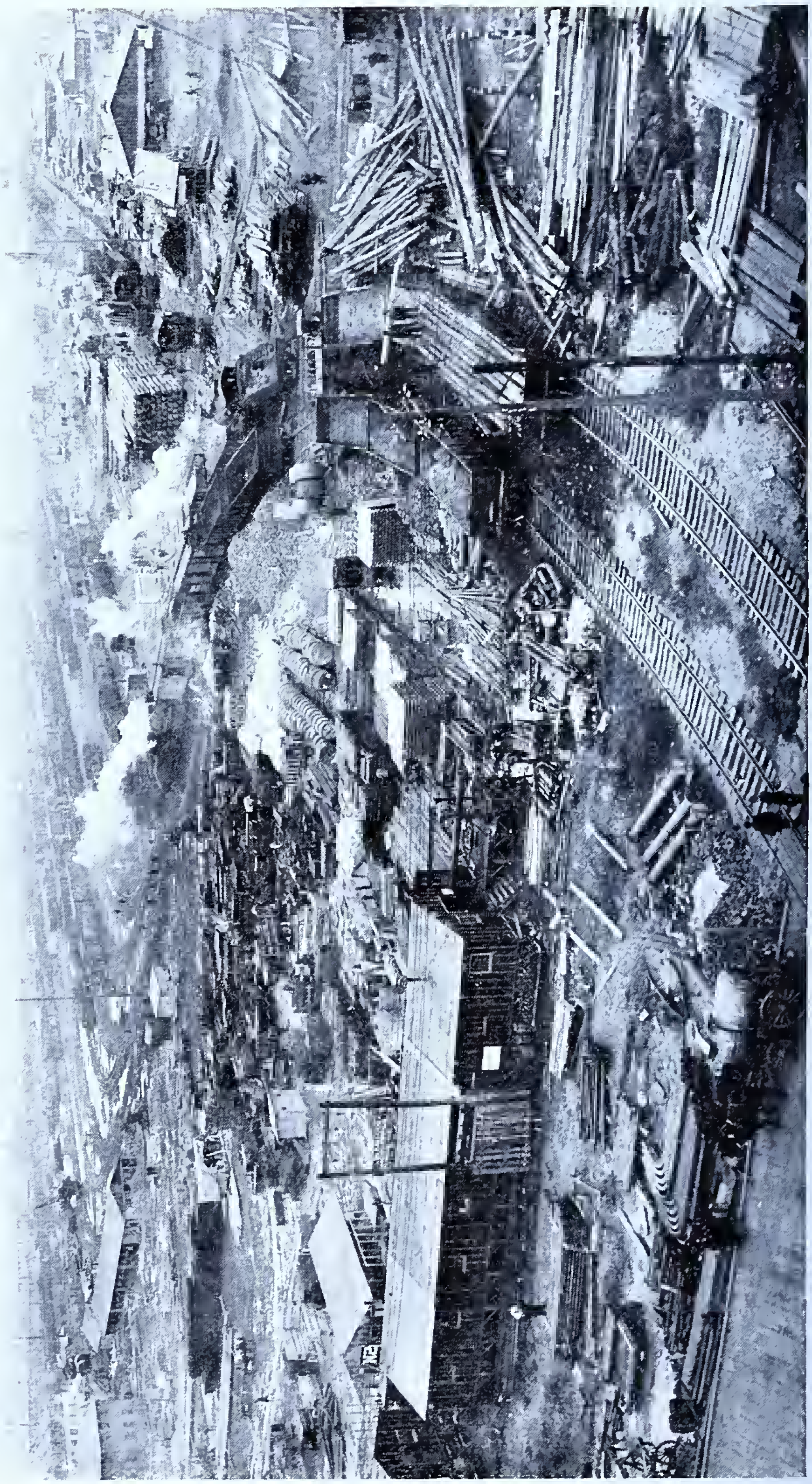
Every vessel stood by itself as a separate piece of workmanship. After the design was carefully made up, the steel and iron required were simply ordered from the mills in commercial shapes and sizes—as plates, angles, channels, etc.—and turned over to the special shops in the yard; the steel plates and members of the framework to be carefully punched with holes for the rivets and bent to the proper curvature; the iron to be forged into stern-post, shafts, and similar units of equipment. Likewise the engines and boilers were of special shipyard manufacture, as well as propeller, funnel, mast, and rudder. *The building of the ship was dependent, as it were, on one set of fine tools.* Ships could not be put together (erected and riveted) on the ways of a given shipyard any faster than this one set of tools could work. Nor was there any use creating more shipyards and more sets of tools if there were no more skilled shipbuilders to use them. Shipbuilding was like the craft of the ironworkers of old Venice—its product was graceful, durable, unexcelled; but it took a long time, and the ultimate quantity of its product was limited by the supply of its own artisans. In face of the fact that the whole nation had now got to devote itself to shipbuilding,



THAWING GROUND WITH LIVE STEAM BEFORE EXCAVATING, FEBRUARY 2, 1918 the industry ignored the division of labor. It had never been changed, because never before had there been a demand for a sufficient number of ships at one time to disturb the old order of things. But now, in 1917, came a demand for 3,000,000 tons more of ships at once apparently out of nothing; and the answer was, Abandon made-to-order methods and manufacture them!

The essence of shipbuilding is in the shops. Once the parts have been put through the shops, it is simply a matter of assembly. Therefore the limitation of ship production is the limitation of the production of the shops. The significance of this led, in the hour of the nation's crisis, to a momentous speculation: "In order to make a big increase in ship output quickly, why could not this shop work be distributed to plants all over the country by supplying them with the necessary patterns?" The only differences between the old method and the new method would be the difference between shops a few yards or many miles from the shipways and the difference between one organization and many different ones. If the existing shipyards, both shops and ways, were overtaxed, were there not hundreds of steel shops throughout the interior of the country capable of fabricating steel to make parts of ships, and, that being so, could not shipways be built at tidewater for assembling these parts? These parts could then be shipped ready-made to the seaboard, there to be assembled into units that would float and carry cargo. There were, of course, no more fabricators of ships' parts as such, but what about the structural and bridge industry, which had attained such great efficiency in this country? Should the nation of mighty steel bridges and towering skyscrapers be limited in supply of beams and frames and plates for ships? The structural industry might truly be called first cousin to shipbuilding. These shops might quickly be adapted to the new purpose, if shown what was wanted. They were specialists in the line of fabricating steel, and they had at hand their trained forces of skilled workers already organized. They were ready and willing to turn their hands to the task.

Here was a bold conception which, if worked out on a sufficiently large scale, would supply the needed ships. It would bring shipbuilding into line with twentieth-century America. Mr. Baldwin, of the American International, who had been making a careful study of the shipbuilding question through the New York Shipbuilding organization, was quick to grasp the possibilities. He saw that this new conception, having been thought out carefully, and being, however startling, absolutely sound, was ready to be translated



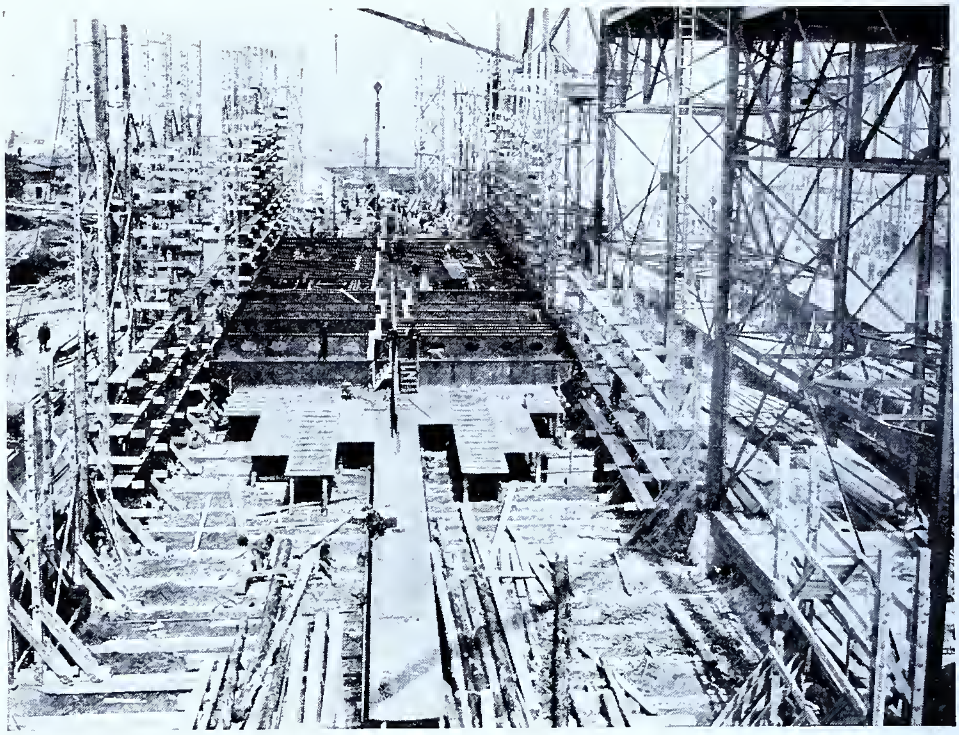
VIEW N.E. FROM CENTRAL FIRE STATION, STORAGE YARD A, FEBRUARY 14, 1918 into action. This was the "fabricated ship" idea. It was—to give that new name its full meaning—quantity production of ships. It was to manufacture quickly in volume as a standardized product what up to then had been, as we have seen, the elaborately fashioned work of the artisan.

But the heart of the matter was this: To make possible this distribution of steel-hull fabrication to many interior plants there must be something more than duplication of standard shipyard types of vessels, as the term "standard" was heretofore understood. For these types were only adaptable to approximate reproduction in the existing yards themselves, by the old methods. The new idea required:

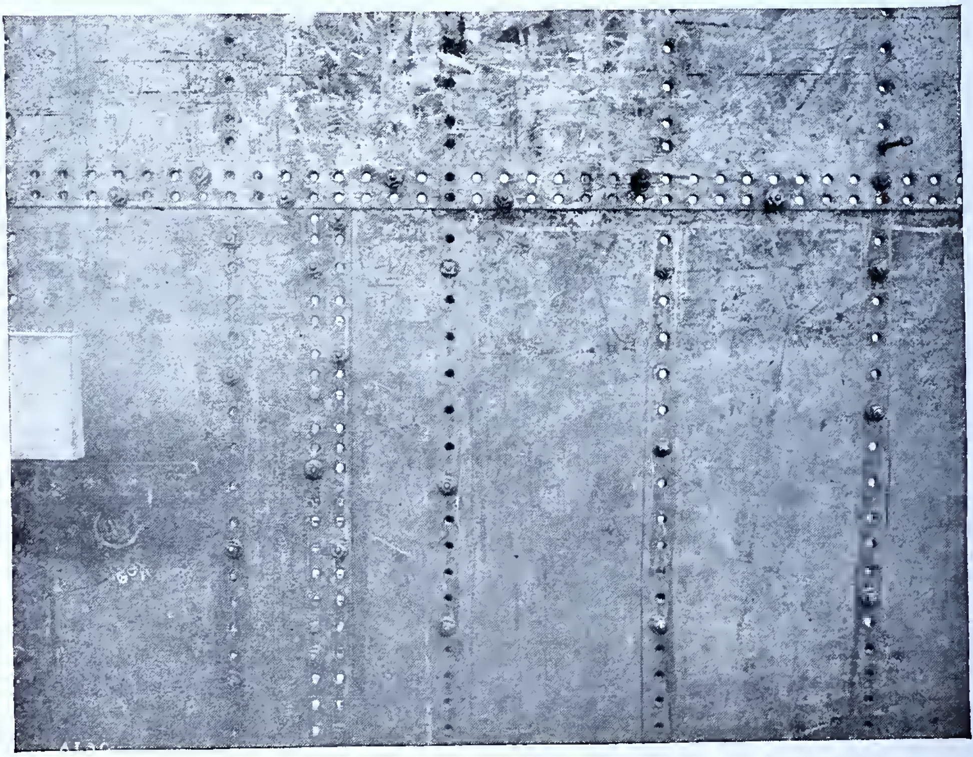
1. *The designing of a steel vessel so radically simplified that all the vessels to be built could be not merely built, but manufactured as exact reproductions.* Thus to standardize construction meant that every possible variation in size and shape of material must be eliminated.

2. *The actual reproduction of these vessels in unprecedented numbers, every one of identical construction, thus permitting the use of the factory methods in which America is pre-eminent.* A big volume of output would alone supply the need for many ships quickly, and a big volume alone would render this tremendous conception itself feasible.

Simplification of design first. All non-essentials must be removed. The traditional vessel of the seas is a structure of elaborate curvature and rakish sweep. The bottom slopes gradually up from the keel (dead-rise); the sides bend gradually in as the level of the deck is reached (tumble-home); beginning amidships, the deck itself has an upward curvature from the horizontal in the fore-and-aft direction (shear); the surface of the deck is a convexity (camber). These sweeping lines mean many curved plates, plates of many curves, a framework of complex bending. Such work as this could not be manufactured; therefore the ship must be squared and straightened. In the midships section it could be made as square as a box, and at the ends the curvature could be reduced to a minimum. This was done by eliminating "tumble-home," and having straight sides; eliminating camber and shear, and having a flat deck; eliminating dead-rise, and having a flat bottom. Thus curvature of plates (particularly that requiring multiple bending) and uneven lengths for upright members were, as far as possible, elim-



HULL 492A, WAY NO. 1, MARCH 30, 1918



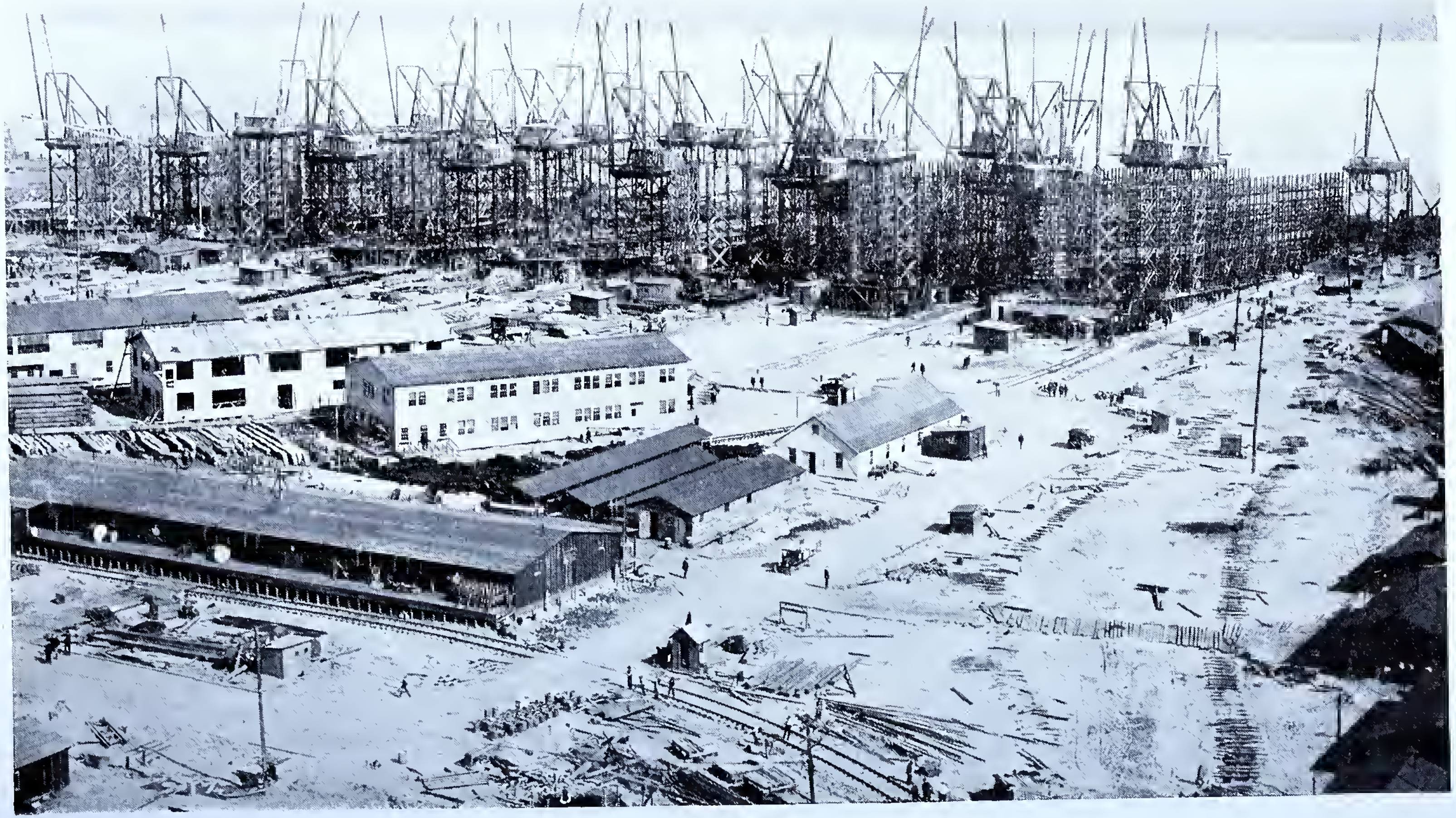
DETAIL RIVET HOLES BEFORE REAMING, MAY 16, 1918 inated. A design of boat was obtained which carefully combined the best shipbuilders' and *bridgebuilders'* practice. As one of the leading engineers described it:

"We took every piece in the ship and examined it to see whether we could reduce the number of operations involved. We called in the shop men and they did the same."

Here was a ship that could be turned over to the structural and bridge builders to manufacture in Pittsburgh, Youngstown, Cleveland, or Toronto, Canada, and the parts forwarded to the coast for assembly. All they needed to begin work was *patterns.* These patterns of the plates, shapes, and other parts, made up in wooden framework, are known in shipbuilding as templets. They are used in every shipyard. The new plan called for a comprehensive system of templets developed to a far greater degree than anything hitherto known in either ship or bridge building to insure such accurate reproduction that all the parts would fit. With these patterns for every different part to guide them, the shops could fabricate 100, 200, or 1,000 ships, if necessary. One templet would serve for a corresponding hull plate, say, for as many ships as the programme called for, since every ship was identical. Limitation of output thus had entirely disappeared.

To manufacture all vessels alike was, it can be seen from this, the essence of the plan. Manufacturing methods apply themselves to uniformity; make uniformity a practical possibility for the product desired, and quantity output is the spontaneous result. Uniformity was a new idea in shipbuilding; but it was right, it was sound, and it saved the day.

It was in the working out of this design of ship, and then of the templets to govern its manufacture, that New York Shipbuilding Corporation fulfilled its function as the technical arm of the American International's shipbuilding programme. Their corps of experienced engineers were admirably prepared to accomplish the solution of this new problem. For it must be borne in mind that the new ship, though radical in design, had to be developed in every detail in line with the soundest shipbuilding practice, embodying throughout the maximum of expert knowledge. New York Shipbuilding Corporation not only co-operated in the development of the design of the 7,500-ton ship to be built by the American International, but they were later to make up in their own shop the templets that would be sent all over North America to serve collectively as patterns for that ship that can be multiplied indefinitely.

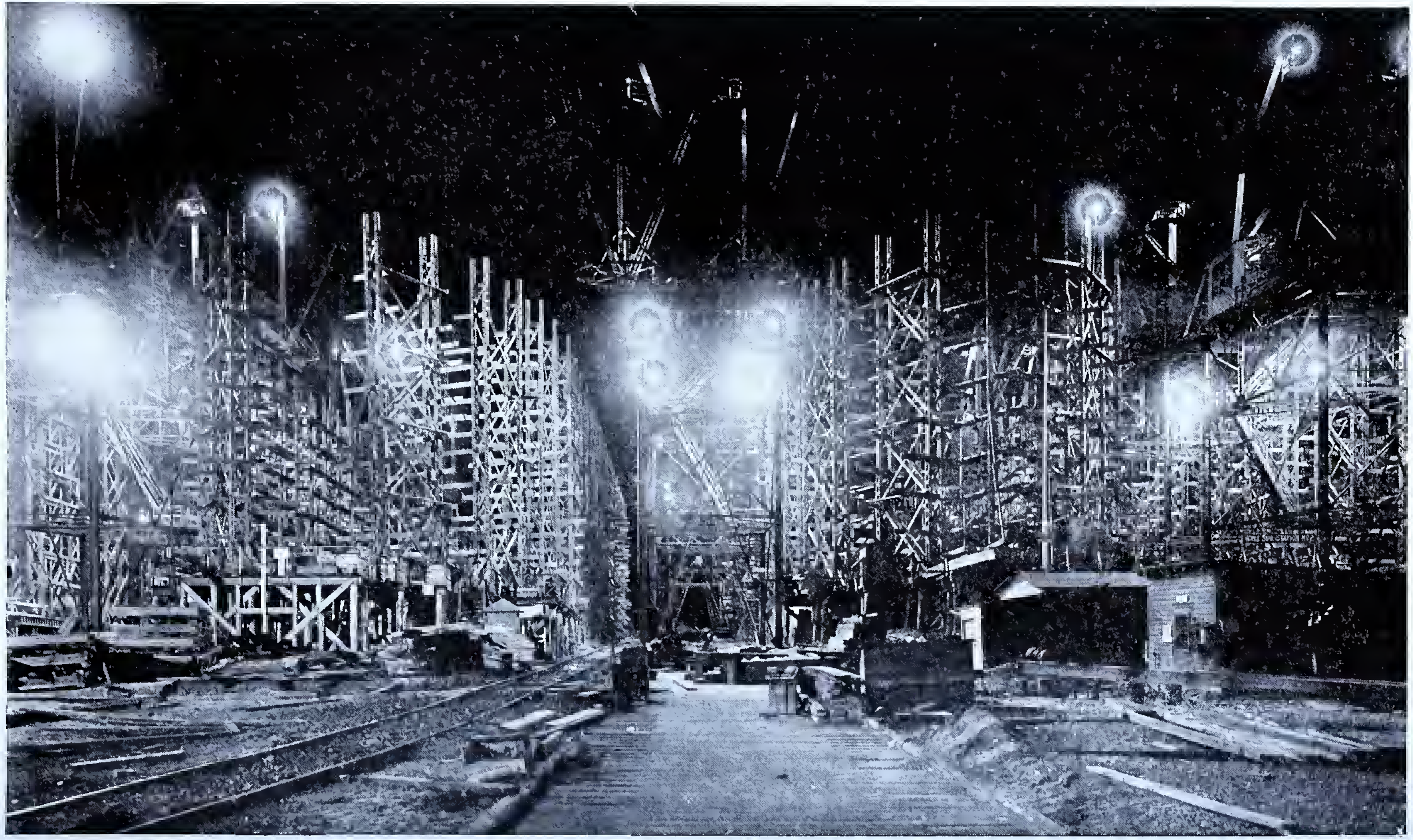


GROUP NO. 1 FROM TOWER, APRIL 29, 1918

It was quickly seen that it would take about 200 ships to work out this multiple production scheme so that it would be most successful. Quantity output has quantity as its *raison d'etre*, so that the order for ships must be large enough to justify the whole operation. Furthermore, as all these ships had to be got quickly, the assembling yard would have to be of large simultaneous capacity, that is, with a much larger number of shipways than had ever been thought of in the traditional conception of a shipyard. Ten ways constituted about the largest shipyard in the world; the American International planned a yard of fifty ways. We needed a lot of ships, and we needed them quickly, and we needed them all at the same time. The idea, in the first place, was a colossal one; it had to be executed on a colossal scale.

Now distribution of manufacture was not confined to the hull of the ship. The engines (turbines) would be ordered from the best engine-builders in the country, whose specialty was engines; the boilers from specialists in boiler construction. All the necessary forgings (as stern-posts, connecting rods, etc.), all the auxiliaries, and in fact every item of equipment going into the finished ship would be placed as special orders with those who had the most available capacity and experience to produce them. In short, the ship was divided up all over the country so that every one might do his share. All the unused resources of the nation which were capable of relating themselves to shipbuilding were mobilized.

By this means, not only was the problem of materials and equipment solved, but, at the same time, the even more crucial one of labor. Skilled shipbuilders could not be had; they were all already occupied in the established shipyards. But skilled specialists in the manufacture of identical or similar items of equipment, which in the number of about 20,000 make up a complete steel steamer, were located at their accustomed tasks all over the country, the already organized forces of many different plants. They could continue right where they were; only let them work at ships' parts instead of tank, or bridge, or skyscraper parts; marine engines instead of land engines; ships' boilers instead of factory boilers. Then there need not be any disorganizing concentration of this available skilled labor at new shipyards, which should rob the old plants, and perhaps not enrich the new yards. None of them needed to change his place or his work; all they needed to do was to alter the purpose of it. At the ship-assembling yard itself, a minimum of skilled shipyard labor would be required, because the



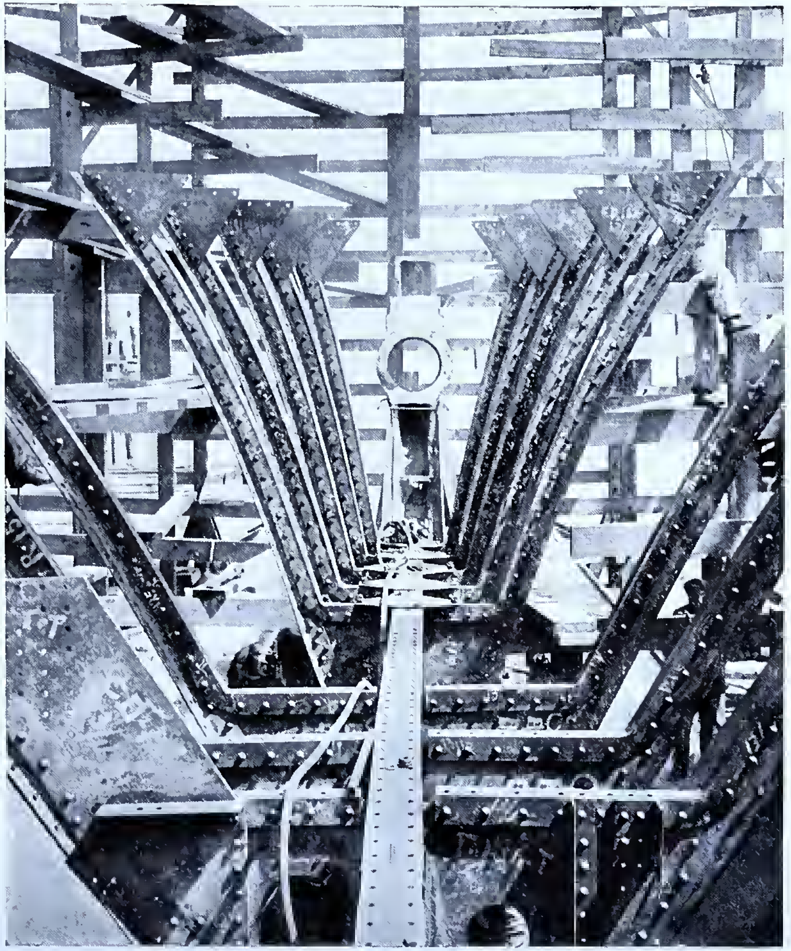
TYPICAL NIGHT LIGHTING OF SHIPWAYS, GROUP 1—11 P.M.—MAY 29, 1918 operations would only involve fitting together carefully reproduced pieces, all of identical pattern, with their places and purposes accurately indicated by numbers. After a little practice it could be made a matter of mechanical precision—simply to assemble ships the way you would motor cars.

In this manner, with the plan of a vast assembling yard to which should flow manufactured parts and equipment from many different portions of the country, you might be said to convert the varied industrial forces of a whole nation into ship-workers almost at a word, and to undertake to put as many ships together as all those workers might turn out.

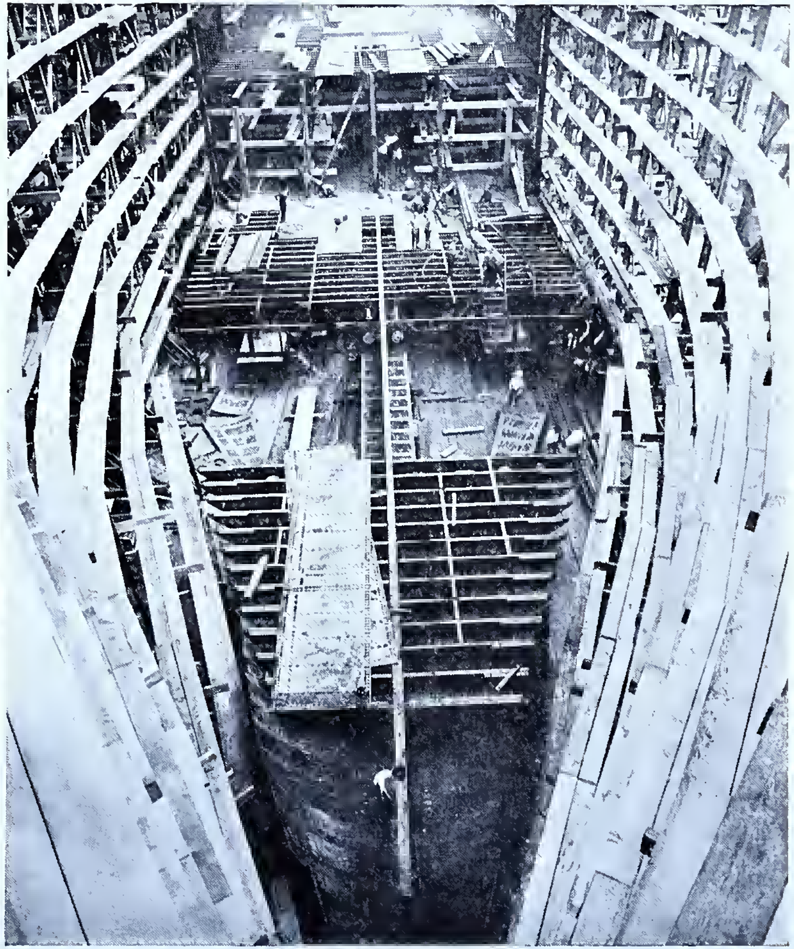
Such an undertaking meant the greatest industrial responsibility that had ever been assumed in this country. It was radical. Old shipbuilders said it could not be done. There would be no condonation for failure. Its scope was unprecedented. Next to the operations of Government itself there was nothing with which to compare it. There would be unexpected problems, for all was as yet untried. It required vision first, to see that it was possible; courage to accept the responsibility; experience in directing cycles of big operations to be able to push it through. It called for organizations and men who should face a task for builders of empire. The American International Corporation and Mr. George J. Baldwin, its senior vice-president, were ready to do their part.

From the very first an essential part of the scheme, as far as the American International was concerned, was Stone & Webster. Synchronizing with the manufacture of parts, the putting together of these new ships was planned to be carried out in an assembling yard five times as large as the largest shipyard in the world. That yard did not exist; it was going to be necessary to create it, and to create it to be ready to begin assembling those parts by the time they should begin pouring out of the shops and factories. It was going to be necessary to perform one of the biggest feats of engineering construction ever undertaken in months instead of years. Mr. Stone, president of the American International, and senior partner of the great engineering firm of Stone & Webster, saw from the first that it would be necessary to have a vast constructing organization of the widest experience to accomplish this. There was no time for building up such an organization gradually; it would have to be ready at a moment's notice.

Stone & Webster were that organization. They had twenty-five years of experience, during which time they had handled many million dollars' worth of contract engineering work of every type.



STERN CASTING SET, HULL 492A, SHIPWAY 1,
JUNE 17, 1918



HULL 492A, LOOKING DOWN FROM TOP OF BOW STAGING,
MAY 22, 1918

Their organized force consisted of several hundred superintendents, engineers and foremen. They were then engaged upon the construction of numerous arsenals and army cantonments for the United States Government, and in particular they were just completing the San Antonio cantonment in record time. What they could do was shown by contemporaneous performance. Their share in this new shipbuilding plan—their enlistment to build the shipyard—was an inevitability.

NEGOTIATIONS

Early in May, 1917, Mr. Baldwin saw General Goethals and told him that the American International was ready to help build the 3,000,000 tons additional of ships by manufacturing them. Two other groups were working along the same lines, the Submarine Boat Corporation and the newly organized Merchant Shipbuilding Corporation. Theodore E. Ferris, then naval architect of the Fleet Corporation, prepared for General Goethals tentative designs of three sizes of boats it was desired to build. These were for a boat of 5,000 tons dead-weight, one of 7,500 tons, and one of 9,000 tons. It was proposed to divide the entire 3,000,000-ton programme into these three sizes of boats, and between the three corporations. Merchant Shipbuilding was to build forty 9,000-ton boats; Submarine Boat 200 of 5,000 tons, and the American International 200 of 7,500 tons; under General Goethals' direction, the entire fabricated ship scheme was worked out with the utmost co-operation between the three groups. "For otherwise," the General had said, "here is what will happen: You will all try to get your pumps from one place; you will all try to get your boilers from one place, and so on, and in that way you will have those places congested so that they cannot produce what you want. But you should distribute your orders around over the industry throughout the country."

In the spirit of what the General had said, the American International went to work through the Spring and early Summer to determine where throughout the country the 20,000 parts of that 7,500-ton ship could be made. The structural shops, the forge shops, the engine and boiler builders, even the makers of ships' hardware, were canvassed. By careful and persistent investigation the collective manufacturers of the complete vessel were tentatively enlisted, and when it is stated that now these ships are actually being assembled from parts comprising the output of some 3,500 factories it can be seen what the task was. The work was so thoroughly done

WAY GROUP 1, LOOKING NORTH, JUNE 17, 1918

DR. EATON ADDRESSING WORKMEN, APRIL 1, 1918 that when in the following Autumn the time finally came actually to mobilize the industry and sign contracts for the output the question took care of itself.

Another part of the Summer's preparations was the search for a site for the yard in which the American International was to build the 7,500-ton ships. It should be near the ocean, yet sheltered from attack by sea; its waterfront should be not less than two miles, the channel deep enough to launch the ships; it should have railway facilities to handle 300 cars a day; it should be near an industrial center with an abundant supply of labor, skilled and unskilled, and housing facilities for both; it should command a supply of electrical power sufficient in itself for a large city. After an investigation of the entire Atlantic coast line from Boston to Baltimore, Hog Island, near Philadelphia, on the Delaware, was chosen.

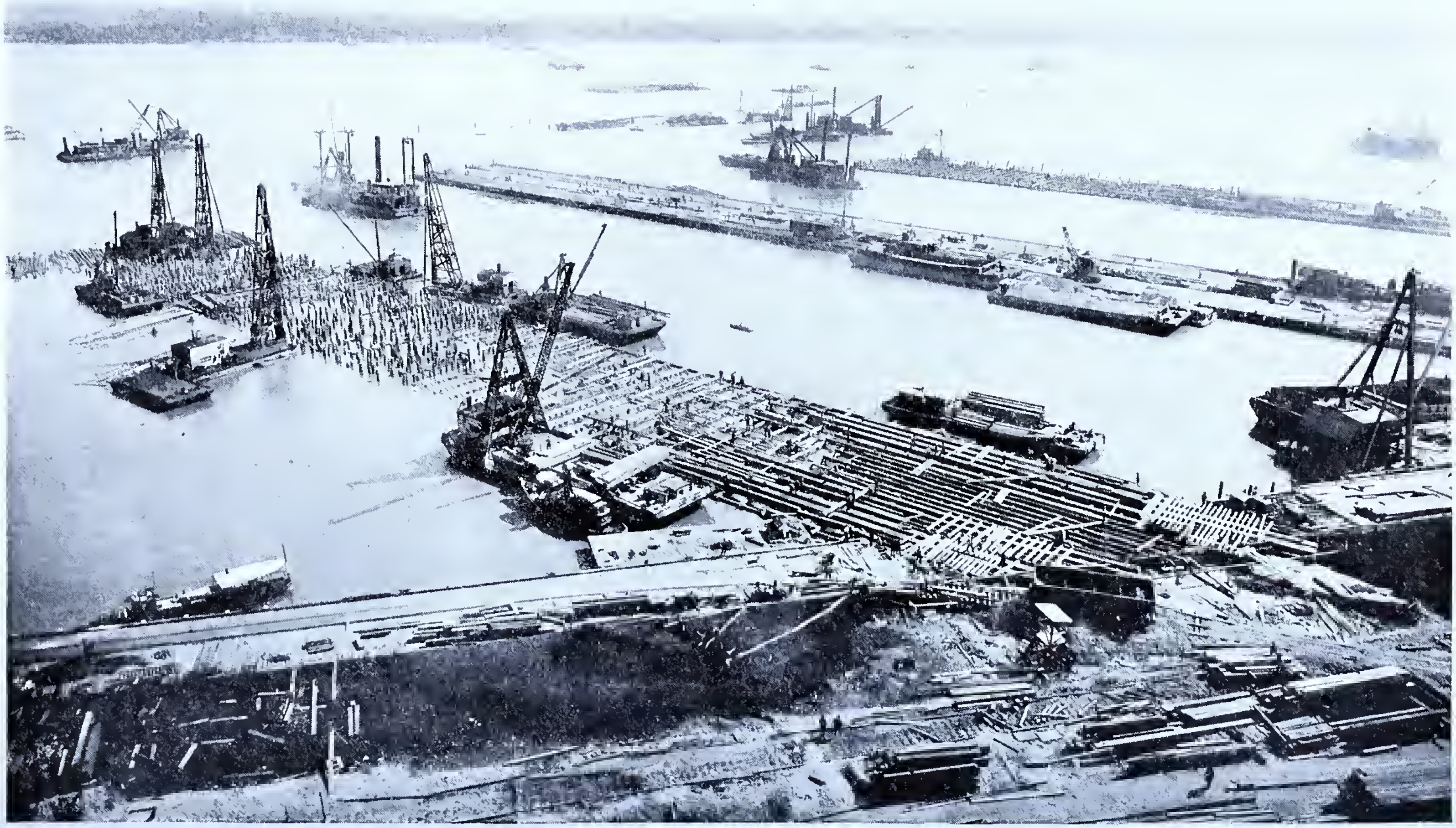
Then, on the 24th of July, 1917, after all preparations had been made and the proposed contract with the Emergency Fleet Corporation had actually been printed, came the resignation of General Goethals, regrettable sequel of a regrettable controversy. It meant inevitable delay; particularly was it unfortunate for the speed of the fabricated ship programme, for, as the contract was finally not signed until the following Autumn, the crux of construction of the shipyard was thrown into the bitter months of the never-to-be-forgotten Winter of 1917-18.

THE CONTRACT

At length, on September 13, 1917, after renewed negotiations with the Fleet Corporation, the contract was signed. It called for the construction of a yard with fifty ways and the building in that yard of fifty 7,500-ton steel cargo steamers of 11½ knots speed, the vessels alone to cost over $50,000,000. It forecast orders for a total of 200 of these vessels.

On October 23rd, a supplementary order (based on an option in the original contract) was signed for seventy 8,000-ton boats of similar type, but with troop accommodations and fifteen knots speed, known as type "B." It was the 7,500-ton boat altered for use as a transport, but equally adaptable to quantity production. This made a total of 120 vessels ordered, and by reason of the change to two types, the latter more costly, was understood as the equivalent of 200 of the 7,500-ton or "A" boats.

Finally on May 7th of this year, a still further order for sixty



PIERS A, B, AND C, WET BASIN SECTION, JUNE 27, 1918 more "A" boats was received, making a total to date of 180 vessels, 110 "A" type and seventy "B" type.

This is the largest single contract in the world, so far as is known. The total cost of the vessels alone is considerably over $200,000,000. The time in which it is to be executed (building both the yard itself and all the vessels) is equally remarkable. The last boat of the 180 is to be delivered complete by August, 1919, or in a total of 22½ months after the signing of the original contract, when nothing existed of the whole project but the carefully worked out plan.

The cost of construction, both yard and ships, is disbursed by the Government as the work progresses, in accordance with modern principles of war finance, not only giving the Government a constant supervision of all expenditures, but avoiding the flotation of corporate securities concurrently with the Government war loans.

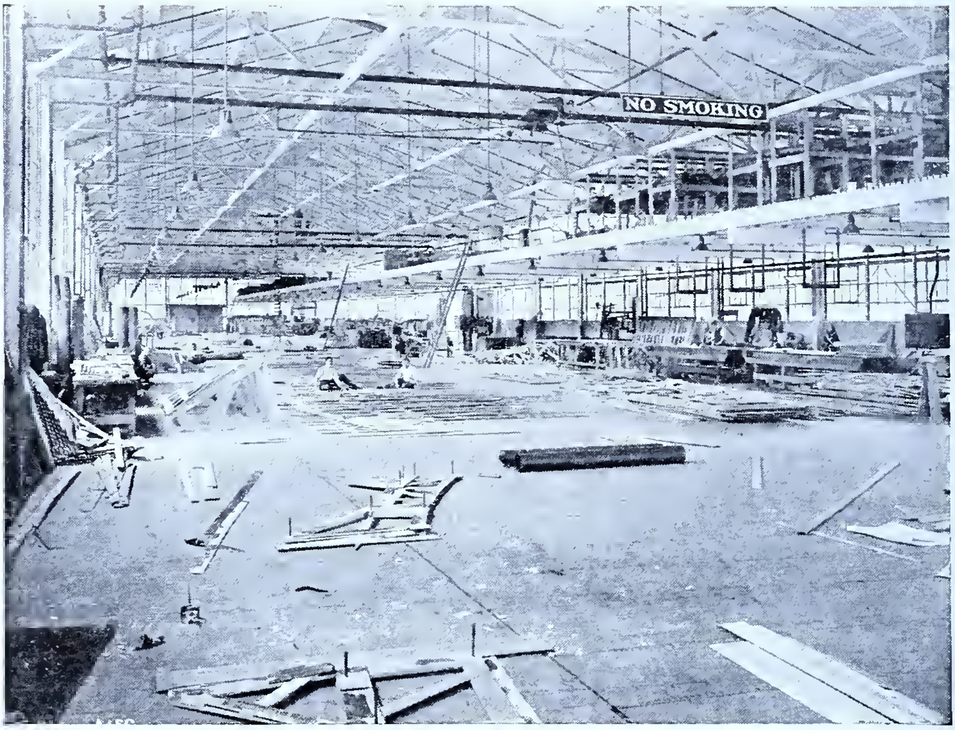
For carrying out this entire programme American International Corporation receives a specified fee for every vessel built; for building the yard itself, no profit whatever. The total normal fee for all the ships actually amounts to about four and a half per cent. of the cost of all the ships, and less than four per cent. of the cost of the entire work, including the yard. As a corporate body to act as agent in performing the contract American International Shipbuilding Corporation was created.

But the essence of the contract was *speed*. The Government said, in formal legal language: "Give us ships, and give us them quickly."

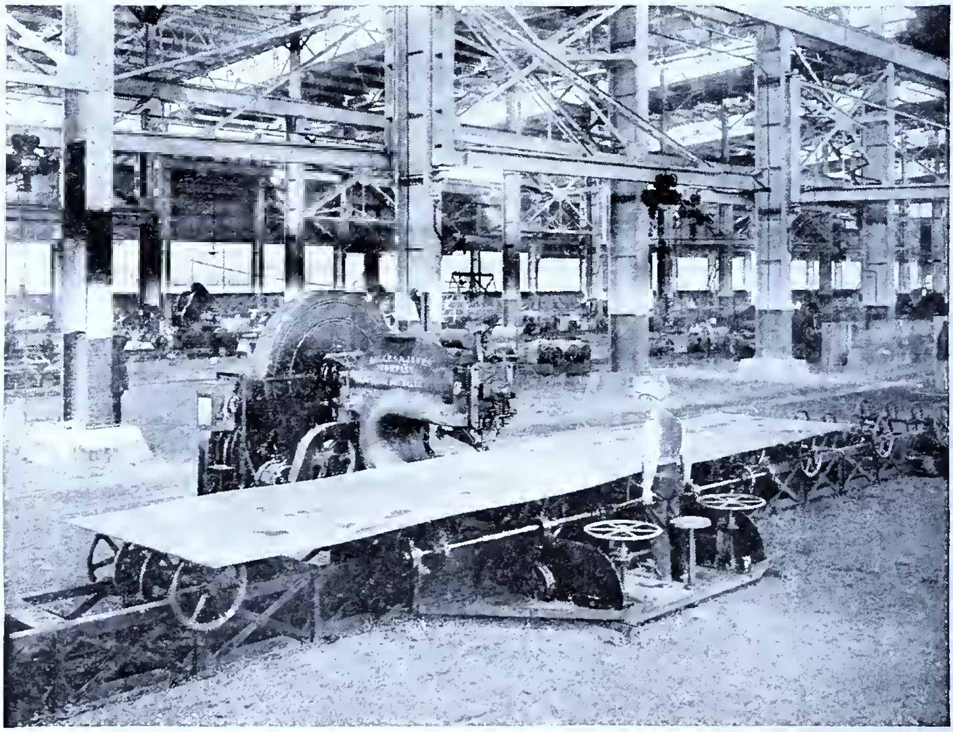
PERFORMANCES

The contract was signed on Thursday. On the following Monday, the general manager of the work (of Stone & Webster) and his staff of assistants were on the ground. A memorable conference was held, and immediately afterward telegrams were sent all over the United States calling 400 superintendents, engineers and foremen of the Stone & Webster organization from other fields. It was the commander-in-chief of a great industrial expeditionary force establishing his headquarters in advance of the coming of the army of workers and summoning his corps, division, and battalion commanders to report for immediate duty. The watchword was "Speed," and it was never changed to any other.

A rough wooded island, the casual haunt of the Autumn sportsman; no roads or, if any, worse than none, and no rail or trolley lines to bring the quickly recruited workmen nearer the scene than a mile and a half. That was the situation. To clear, to dig, to



INTERIOR OF TEMPLET SHOP, JULY 8, 1918

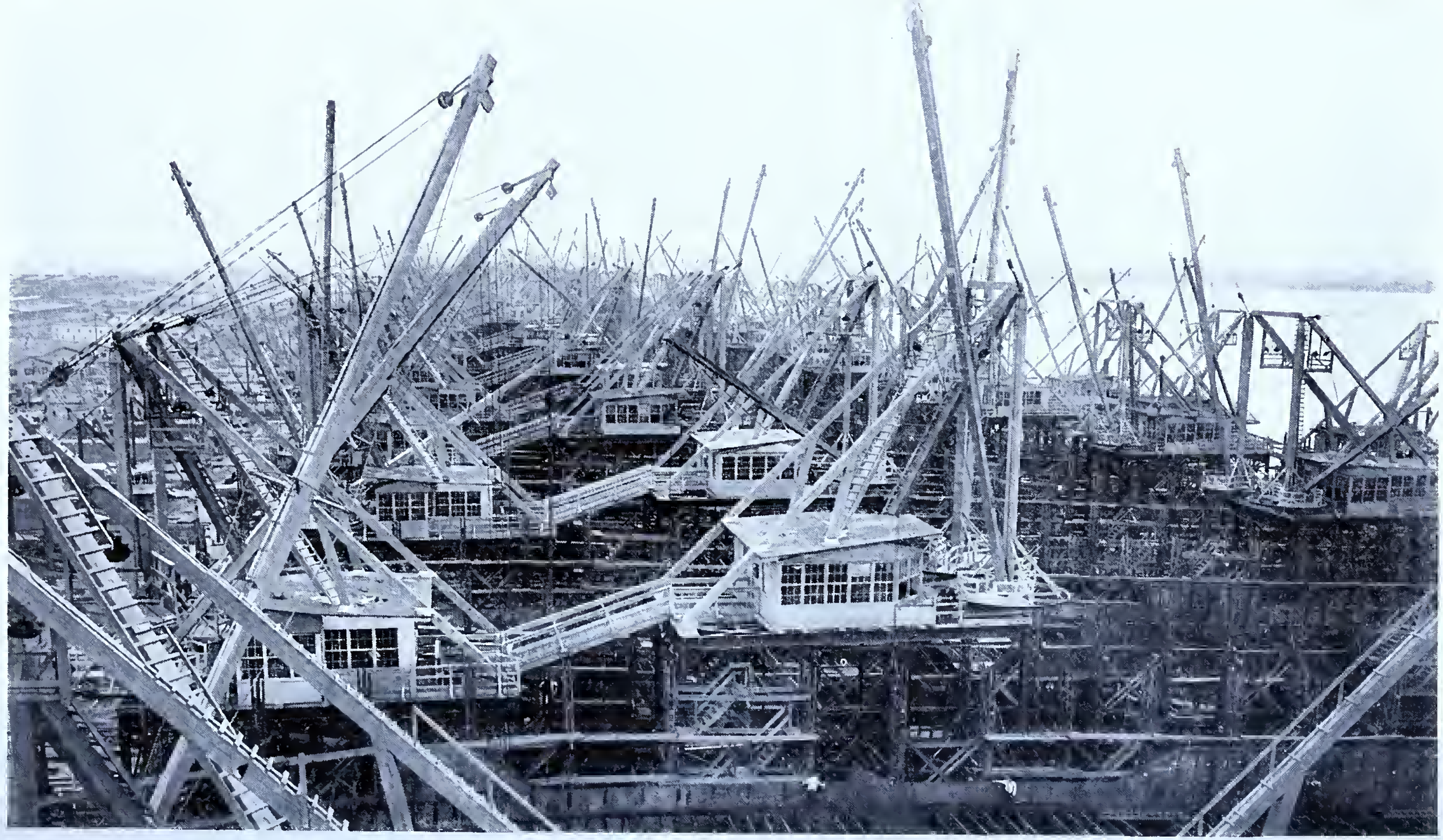


SHIP PLATE RIVET HOLE PUNCHING, PLATE AND ANGLE SHOP, JULY 11, 1918 make roads, to grade, to lay tracks, to drive piles, to build, those were some of the things that had to be done at once. At most there would be only about two months of good weather before the Winter set in. And the yard was to be built in ten months! Surveyors, engineers, construction men were now team-mates, now competitors in a continuous engineering relay race. But what with a less tried organization might have been mere haste, with this one was real speed, because to these men a right decision meant not the choice between two different ways of doing a thing, but the one inevitable way taught by experience.

There was a task ahead for which, in size and in time to complete, the past furnished no comparisons. Here were some nine hundred acres of land to be converted in a few months into an industrial city of over 25,000 workers, which should also be the greatest shipbuilding machine ever created. There was this enormous working force itself to be enrolled as quickly as it could be and their numbers kept at full strength regardless of turnover. Of these, many thousands must be fed and sheltered on the island itself; for the many thousand others, housing must be found in nearby Philadelphia, and the means of transit back and forth. At the scene of work these thousands of men must be kept continuously deployed at the successive points where they were needed. There were temporary buildings, then shops, office buildings, workmen's barracks, warehouses, an immense railway switching system, a mile of shipways and a mile of wet basins to be built. There were power facilities, water facilities, handling facilities for the yard; hundreds of derricks and other handling machinery for the ways to be installed. For this building and this installation a quantity and diversity of materials, equipment and stores must be ordered, such that its volume pouring into the yard would keep four or five thousand loaded freight cars continuously routed toward Hog Island, of which at least 100, and sometimes over 300, would have to be received and unloaded every day. It was to perform one of the biggest engineering jobs the world has ever seen practically overnight.

OVERCOMING THE ENEMY'S ALLY, WINTER

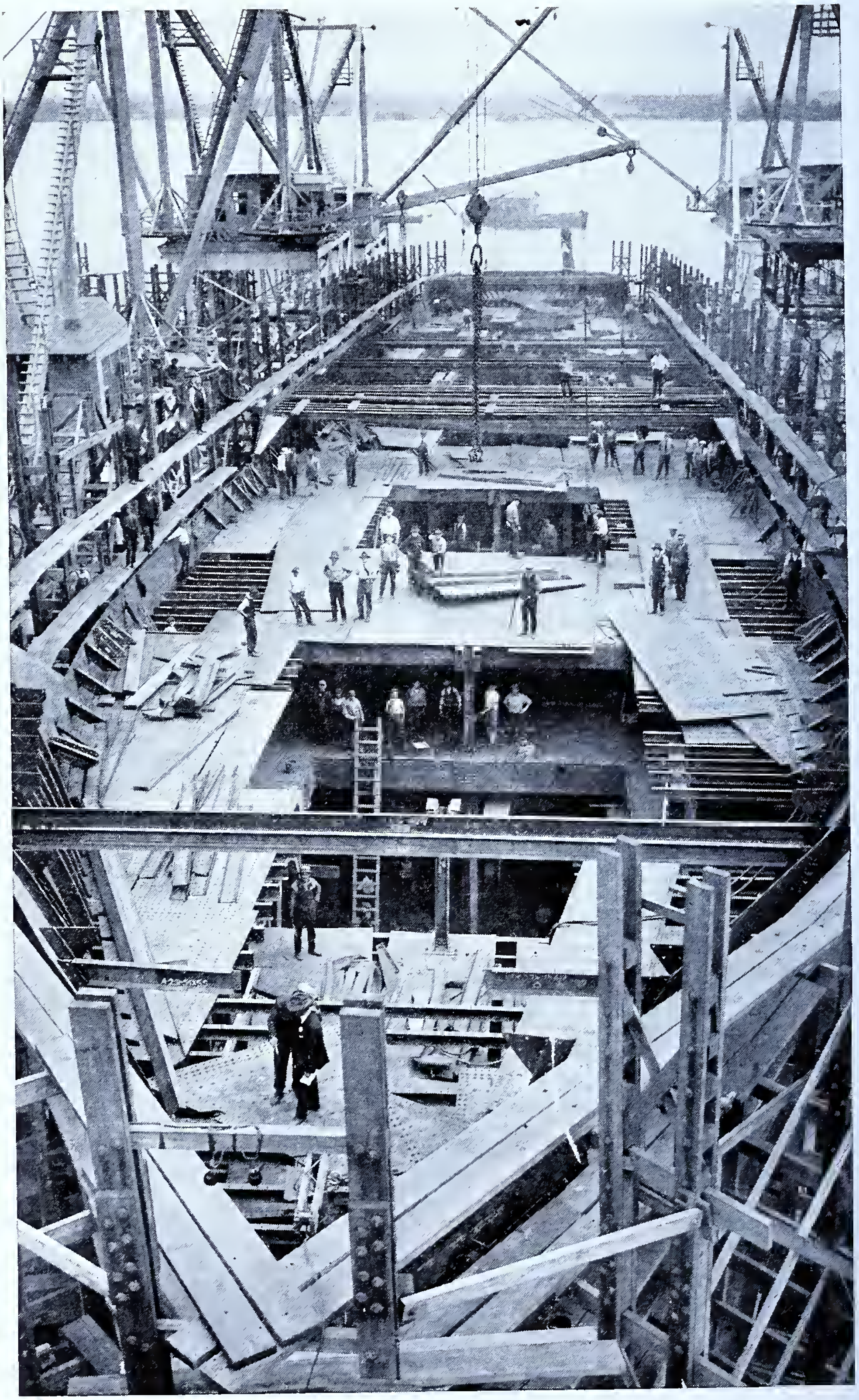
Early in December the coldest Winter in living memory set in and continued until March. During the whole of December and January the thermometer went above freezing only twice, and most of the time it was far below. February was little different. The work could not stop. There was no shelter for the men from the



LOOKING EAST FROM WAY NO. 1, SHOWING FOREST OF DERRICK MASTS, JULY 9, 1918 biting wind. Materials came in on the freight cars frozen solid. Hundreds of car-loads of cinders had to be thawed out with steam. A thousand tons of coal a day were needed, and the cars came in frozen so that it all had to be picked out. The shipways and basins called for the use of no less than 150,000 piles, and of these an immense number had to be driven during those months through the frozen earth. Where ordinarily there would have been a few inches of frost in the ground, that Winter it went down over three feet. The ground had to be thawed out with live steam or dynamited. Also, in spite of these conditions, 90,000 feet of high-pressure piping, 120,000 feet of domestic water-piping, and a sewerage system for 30,000 people with nearly fourteen miles of pipes—all had to be put down. The trenching could not be done by pick and shovel, although there were 10,000 picks and 20,000 shovels! It all had to be blasted out.

During these days transportation from Philadelphia for the workers, inadequate before, all but failed. The men often spent two hours each way between work and home. A heavy shifting in the force was inevitable. To keep the number up to the twenty or twenty-five thousand needed often required a weekly enrolment as high as thirty-five thousand. But those that stayed worked on with earnest heroism through rigors nearly as great as those of the trenches overseas, because they realized that the work they were doing was next in importance to the work in the trenches. And because they did their part then, and their foremen and superintendents and executives did their part, though to the heavy hardships of that Winter was added the worse one of the world's criticism, the result to-day is—the work was completed on time!

The yard is practically complete to-day, ten months after the first surveyor ran a line through the length of the island—a shipyard as large as Cramp's, Fore River, Maryland Steel, Newport News, New York Shipbuilding and Union Iron Works, all together, at the outbreak of the war. There are, side by side, extending for a mile and a quarter along the river-front, fifty building ways for ships, completely equipped with a highly flexible system of derricks for assembling. These ways are operated in ten groups of five, each of which groups, with auxiliary buildings and tool-shops, is an independent ship-assembling unit. Adjoining these and forming a continuous water-front for another mile and a quarter (which makes a total of two miles and a half) are the ship-outfitting basins, with seven piers, each 1,000 feet long, and outfitting berths to accommodate twenty-eight vessels at one time during the period



HULL NO. 492, WAY NO. 1, JULY 9, 1918

between launching and completion. To bring into the yard, sort, and distribute to the ways and basins the unassembled ships' parts—output of over threescore structural shops and of over three thousand factories of every kind—there is a railway terminal system of eighty miles of tracks. This is divided into an immense classification yard and two material storage yards, comprehensively interconnected with spurs to the ways. In these yards along the tracks are piled the fabricated steel parts as they arrive, whose total quantity for all the ships now on order will be about 500,000 tons. The lighter equipment is stored in a mile's extent of freight warehouses. The work of loading and unloading in the yard constantly occupies seventy large locomotive cranes.

There are twenty-five acres under roof, about 250 permanent buildings; first of all, the shops: plate and angle shop, templet shop, machine shops, pipe shop, air tool shop, etc. Then there is the second largest air-compressor plant in the world with a capacity of 75,000 cubic feet per minute. There is a central administration building housing 1,650, and an engineers building for 750 engineers and draughtsmen. There are barracks for 6,000 workmen, three guards' barracks, a handsome Y. M. C. A., a hotel, a central cafeteria, mess halls, a model emergency hospital, besides the innumerable auxiliary buildings which make up a city within itself. Serving all is an electric power sub-station of 24,000 kilowatts. It is one of the permanent headquarters of industrial America mobilized—on active service!

THE SUBMARINE'S THREAT ANSWERED

As for ships—building them began when the yard was only half completed. There are now thirty-seven vessels on the ways in progressive stages of construction. Very soon there will be fifty. At the height of activity, which will be before the end of the year, there will be fifty vessels on the ways, and twenty-eight more—already launched—in the finishing basins; or seventy-eight under construction at one time—over two miles of ships! As fast as the boats are launched other keels will be laid, and as fast as they are delivered others will pass to the outfitting piers. Three steel hulls a week will slide from the launching ways into the Delaware, and three completed steel steamers a week will be delivered to the Government. Everything is on schedule time. All promises have been fulfilled.

Thirty thousand men are engaged on this work in a spirit of

MATERIAL IN STORAGE YARD A

STEAM AND TROLLEY TRANSPORTATION FROM HOG ISLAND, JULY 15, 1918 the keenest emulation. New men are rapidly trained, 600 at a time, in a school for shipbuilders on the Island, and readily take their places beside the others. All are becoming adepts in the new trade of ship erection and assembly, which, it may be said, is giving better results even than anticipated. Those fabricated parts, from North, East, West, and South, *fit*, and generally not even the rivet holes have had to be adjusted.

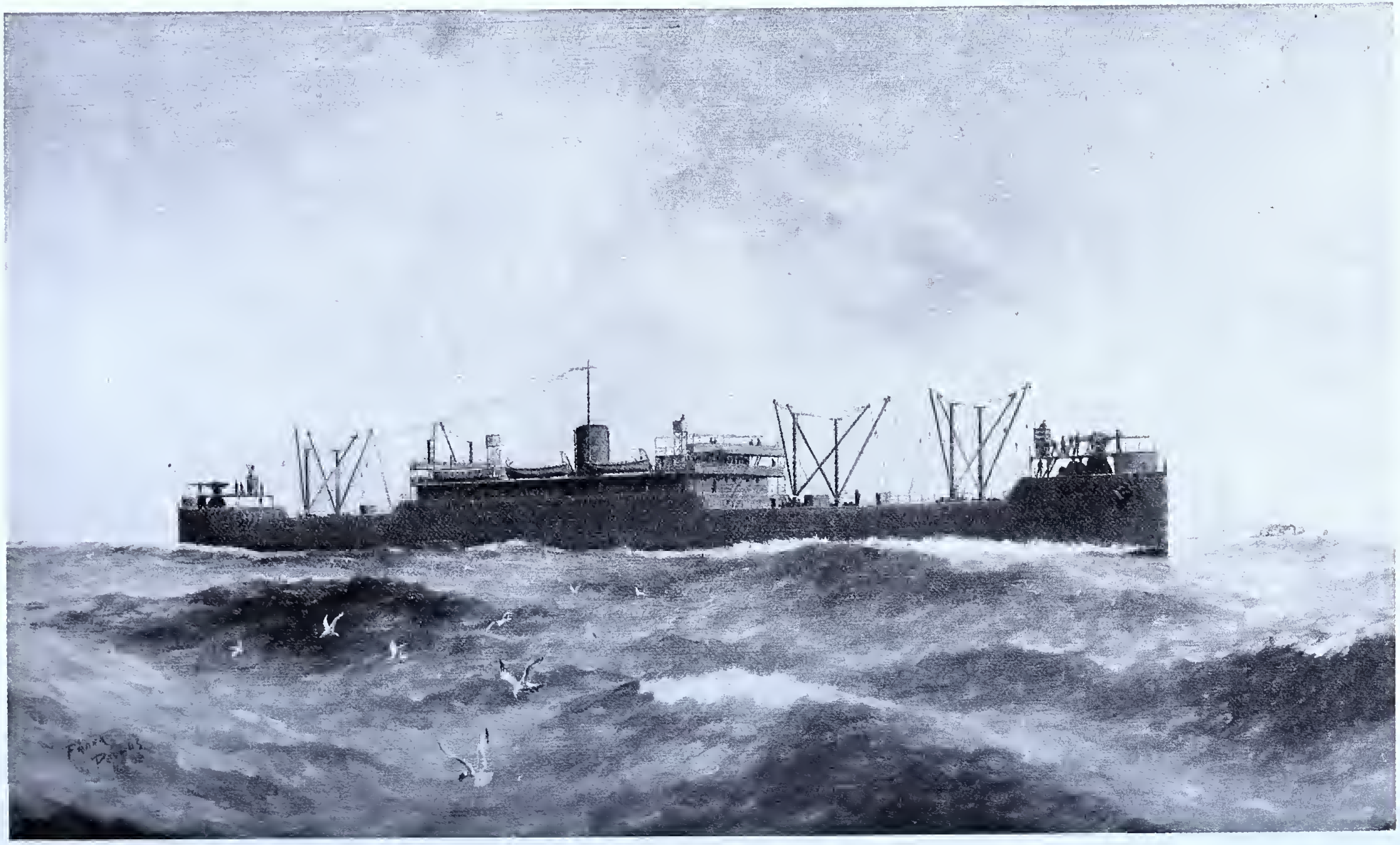
These workers know well the part they are playing. It is not for nothing that their riveting machines are called "guns," for although they are not weapons of attack, but weapons of construction, their effective work is ultimately solving the problem both of attack and defense, for it is placing millions of armed men in that line in France long since recognized as the frontier of civilization.

August 5th was the date set for the first of the fabricated ships from Hog Island to take the water, with a splash that must soon swell into a tidal wave rolling in the direction of Germany. It is a date of importance in the history of America's part in the great war, for when that history comes to be written, the fabricated ship will have a worthy place. The launching of this vessel, witnessed by about 75,000 people, is the earnest of at least 179 other vessels to follow from this yard alone—a promise from America to her Allies. It is the proof that the threat of the submarine has already been answered; that soon it will be nullified.

This boat is a 7,500-ton steel cargo steamer, 400 feet long, 54 feet beam, and 24 feet draught loaded. When completed she will have a 2,500-horsepower turbine engine capable of driving her at a speed of 11½ knots. She will have the highest marine classification from the American Bureau of Shipping and Lloyd's—100A1.

In twenty-two and a half months from the time the contract was signed Hog Island will deliver 1,385,000 tons carrying capacity of ships. When the yard is in full operation it will have a capacity of 1,500,000 tons per year. This is over three times the entire yearly shipbuilding output of America before the war, which was only about 400,000 tons.

By the fabricated method, production of ships can be increased practically without limit. It is not necessary to build more shipyards. Increase the output of the structural steel shops, build more structural shops to make the parts, and there is no end to the number of ships that can be put together and sent to sea, per year, per month, and per day!



THE TYPE "B" SHIP

THE OUTLOOK

In this manner we are erecting a *bridge of ships* (apt name!) fabricated by the structural and bridge builders of America—a bridge of ships to France and to Britain. Then while our bond with France was sealed anew in the memorable words of General Pershing: "*Nous voici, Lafayette!*" announcing the coming to those shores of American land-power, let our new bond with Britain be sealed by the timely arrival to the aid of British sea-power, in the greatest crisis of the world's history, of American sea-power. Let this new transatlantic structure of ships bridge the old misunderstandings, too long played upon by the counselors of disaffection. Thus, as we see the laden American ships steaming past Hog Island down the Delaware and out to sea, we can picture for the future two mighty merchant marines, American and British, guarded if necessary by invincible navies, which shall jointly work and watch to maintain a new idea of sea-power, as unshakable as it is beneficent. Then let no more the specious cry be raised, "Freedom of the seas," by any nation intent upon destroying that freedom, for the pretensions to power of such a one will go the way the submarines of to-day are fated to go—to borrow the phrase of their own makers, "*spurlos versenkt*"—sunk without a trace.

FACTS ABOUT HOG ISLAND

Area of the yard	846 acres
Length of waterfront	2¼ miles
Length of railroad tracks in yard	80 miles
Length of roadways	18 miles
Number of shipways	50
Number of outfitting piers	7
Length of each	1,000 feet
Area covered by buildings	25 acres
Amount of finished lumber used in buildings	110,000,000 feet
Number of piles driven	150,000
Length of domestic water piping	22¾ miles
High-pressure piping	17 miles
Underground electric wires	568 miles
Number of shovels used	20,000
Number of men employed (average)	26,000
Present weekly payroll	nearly $1,000,000
Number of ships to be constructed	180
Total dead-weight tonnage	1,385,000
Tons of steel required	500,000
Number of rivets required	90,000,000
Total estimated cost of yard and ships	$315,000,000
Average monthly expenditure	over $10,000,000

(N. B.— Average monthly expenditure on Panama Canal, $2,500,000)

	("A" SHIP)	("B" SHIP)
Length over all	401 feet	450 feet
Tonnage dead-weight	7,500	8,000
Tons displacement (loaded)	11,200	12,460
Speed	11½ knots	15 knots
Fuel	Oil	Oil
Motive Power	Geared turbines	Geared turbines